

WORK PLAN FOR DRILLING AND MONITORING WELL INSTALLATION

Monsanto Soda Springs, Idaho Plant

Submitted To: Monsanto Soda Springs Plant

Highway 34

Soda Springs, Idaho 83276

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March 29, 2011

Project No. 913-1101.605A







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1.0 INTRODUCTION

This Work Plan presents the purpose, scope and methods for the installation of additional groundwater monitoring wells in the area west and south of the Monsanto Soda Springs Idaho Plant (Plant) site. The additional monitoring wells were requested by the U.S. Environmental Protection Agency (USEPA) and the Idaho Department of Environmental Quality (IDEQ) following review of groundwater conditions at the Plant site (CH2M Hill 2010). The groundwater monitoring wells will be installed to collect additional geologic, groundwater elevation, and groundwater quality data to define the downgradient extent of the plume originating from the old Underflow Solids (UFS) Ponds, evaluate the hydraulic behavior of the Subsidiary Fault, and to evaluate groundwater conditions in the area to the south and southwest of the Plant site.

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This Work Plan is organized into the following sections:

- Section 2 presents a brief background section that includes a brief description of existing groundwater monitoring wells and groundwater conditions at the site
- **Section 3** present the approach to the field investigations
- **Section 4** describes the field investigations
- Section 5 presents a schedule to complete the work
- Section 7 includes references

All work will be performed in accordance with State of Idaho monitoring well construction regulations (IDAPA 37.03.09, IAC 2010a) included in Appendix A and the technical procedures and quality assurance/quality control procedures presented in Appendix B.



2.0 BACKGROUND

The Monsanto Soda Springs Plant (Plant) is located one mile north of the City of Soda Springs, Caribou County, Idaho (Figure 1). The site covers an area of approximately 800 acres, with the fenced plant site accounting for 540 acres.

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Monsanto purchased agricultural land in 1952 to construct the Soda Springs elemental phosphorus production plant. The Plant uses locally mined phosphate ore. In 1984, Golder Associates Inc. (Golder) was retained to assess the impact of operations on groundwater and surface water quality at the Plant. The 1984 study found elevated concentrations of cadmium, selenium, fluoride and sulfate in groundwater beneath the Plant (Golder 1985). The sources of these constituents were determined to be the Old UFS Ponds, the Northwest Pond, and the Old Hydroclarifier. The investigation also concluded that groundwater under the southeastern portion of the plant contained elevated concentrations of vanadium, chloride, and sulfate. Based on groundwater flow directions and geochemical data, the elevated concentrations of these constituents in the southeastern portion of the Plant were attributed to the Kerr-McGee Chemical Corporation (now Tronox) facility located to the east of the Plant, across Highway 34 from the Plant, and was further supported by findings from a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) site inspection conducted in 1988 and supported by the results of the Remedial Investigation / Feasibility Study (RI/FS) activities completed at the Plant (Golder 1992, 1995).

Monsanto conducted and submitted to the USEPA a RI in 1992 (Golder 1992) and a Phase II RI in 1995 (Golder 1995). A Record of Decision (ROD) was signed by Monsanto and the USEPA in 1997. The selected remedy for groundwater is monitored natural attenuation. Bi-annual groundwater monitoring was in place from 1991 to 1998, and annual groundwater monitoring has occurred since 1998. Annual groundwater, surface water, and effluent discharge monitoring is conducted at and near the Plant in order to ensure that natural attenuation is proceeding per modeled predictions (Golder 2008), and to monitor the natural attenuation process. Annual groundwater and surface water quality reports are prepared following completion of the annual sampling to evaluate groundwater quality and short-term groundwater quality trends. Long-term groundwater quality trends are statistically evaluated as part of the Five-Year Review process (Golder 2003, 2008).

2.1 Hydrogeology

The hydrogeology at the Monsanto Plant is presented in detail in Golder (1995), and updated in Golder (2010b). The primary hydrostratigraphic zones underlying the Monsanto Plant include the Upper Basalt Zone (UBZ) and the Lower Basalt Zone (LBZ). The principal aquifer is the UBZ which extends to a depth of about 100 feet below ground surface (bgs) below the Plant and the area surrounding the Plant. The UBZ consists of up to three permeable interflow zones designated γ 3, γ 4, and γ 5 that consist of cinders,





broken and rubbly basalt, and sedimentary materials. The interflow zones are separated by lower-permeability basalt flows. Groundwater elevation data and pumping tests demonstrate a vertical hydraulic connection between the UBZ interflow zones (Golder 1995).

The depth to the water table ranges from 20 feet bgs in the northeast corner to 100 feet bgs in the center of the plant. Groundwater flow in the UBZ and LBZ is a function of faulting, regional hydrogeologic conditions, and pumping of the plant production wells. The UBZ and LBZ are broken into smaller regions (UBZ-1 through UBZ-4 and LBZ-1 through LBZ-4), based on faulting, hydrogeological controls, and groundwater quality (Figure 2). Details pertaining to the breakdown of UBZ and LBZ regions are provided in Golder (1992) and Golder (1995).

CH2M-Hill (2010) reviewed the 2009 groundwater conditions report (Golder 2009a) and identified several uncertainties in the conceptual hydrogeologic model of the site in UBZ-2, including the hydraulic nature of the Subsidiary Fault separating UBZ-1 and UBZ-2 west of the Plant, and areal distribution of the constituents of concern, particularly selenium, south and west of the Plant fenceline in UBZ-1 and UBZ-2. The monitoring wells proposed for 2011 are designed to address these uncertainties.

2.2 Monitoring Locations

Figure 2 shows the location of existing groundwater and surface water monitoring locations in UBZ-1 and UBZ-2 south of the Plant.

2.2.1 Groundwater

Groundwater affected by Monsanto activities is mainly confined to the UBZ within the Plant, with groundwater flow southward toward the South Plant fenceline. Plume migration originating in the UBZ-2 from the Old UFS Pond within the Plant boundaries is monitored by South Fenceline wells TW-20, 34, 35, and 39. South of the Plant fenceline in UBZ-2, the plume is monitored by Southern Boundary wells TW-53 through TW-56; inclusive, and monitoring wells TW-59 and TW-62. The South Fence Line wells are located inside the southern Plant fence line immediately north of Hooper Springs Road (Figure 2); the Southern Boundary wells are located within Monsanto property about 1,200 feet south of the Plant fenceline (Figure 2). TW-59 and TW-62 are located about 3,300 and 2,000 feet south of the Plant fenceline, respectively.

UBZ-2 groundwater south of the Plant fenceline is also monitored in several springs including Calf Spring, Mormon A, B, and C Springs, and Mormon Creek, which is formed by the discharge from Mormon A, B, and C Springs and groundwater discharge (Figure 2).

In UBZ-1, groundwater is monitored in the southwest corner of the Plant in wells TW-07, TW-08 and TW-10 located at the southwest Plant fenceline. UBZ-1 groundwater is also monitored at Southwest





Spring, west of the plant, and in wells TW-60 and TW-61 and Homestead Spring southwest of the Plant (Figure 2).

2.2.2 Surface Water Monitoring

Surface water flow and quality is monitored in Soda Creek at several locations south and west of the Plant. Station SC-1 monitors water quality upgradient of the irrigation and power diversion weir, where most of the flow in Soda Creek is diverted into a canal. Station SC-5 (Soda below Weir) is the first station on the creek below the weir. Flow at SC-5 consists of seepage through the weir flashboards.

Station SC-3 (Soda Mid) monitors flow and water quality in Soda Creek immediately above the confluence with Mormon Creek. Flow at this location consists of groundwater seepage to Soda Creek and discharge from Southwest Spring.

Downstream of the Mormon Creek confluence, flow and water quality is measured at stations SC-4 (Soda Down) and SC-6 (Soda at Property Line). SC-4 is the first station downstream of the Mormon Creek confluence, and includes flow from Soda Creek (including Southwest Spring) and Mormon Creek. SC-6 monitors flow at the Monsanto property line, and includes flows in Soda Creek and groundwater discharge.

Additional stations monitor surface water quality in Soda Creek downstream of the Monsanto property line and power return (SC-7) and at Octagon Park (SC-8), and station PR-1 monitors water quality in the irrigation and power canal upstream of the power plant.

2.3 Groundwater Conditions

The most recent annual groundwater monitoring results at the Monsanto Soda Springs Plant are presented in the 2010 Summary Report (Golder 2010a). The report is based on groundwater quality data collected up to and including the May 2010 sampling round (completed May 18 through 25, 2010). Results show concentrations of several constituents of concern (cadmium, selenium and nitrate) are increasing in South Fenceline wells (TW-20, TW-39), Southern Boundary wells (TW-53, TW-54, and TW-55), and in several offsite, downgradient springs (Mormon A and Homestead) in the UBZ-1 and UBZ-2 zones. In addition, selenium exceeds the remediation goal of 0.05 mg/L in monitoring wells TW-59 and TW-62.

Chemical isopleth maps (Golder 2010a) indicate the plume in UBZ-2 originating from the Old UFS pond has extended beyond the Southern Boundary wells and appears to migrating towards the south Monsanto property boundary and Soda Creek. The southern extent of the plume is cannot be delineated based on the existing monitoring network.





The UBZ-2 plume originating from the Old UFS Pond appears to have migrated across the Subsidiary Fault west of the Plant to UBZ-1 because of a change in displacement or offset on the fault, resulting in juxtaposition of permeable interflows across the fault. Elevated concentrations of several constituents of concern, particularly selenium, occur in UBZ-1 at Southwest Spring and TW-10. Additional information on the controls on the migration of the constituents of concern within UBZ-1 are required.

Groundwater discharge to Soda Creek (in the form of discharge to Southwest Spring, Mormon A, B, and C Springs, and diffuse groundwater discharge to Soda Creek and Mormon Creek) has resulted in exceedances of the State of Idaho chronic aquatic standard (IDAPA 58.01.02, IAC 2010b) for selenium of 0.005 mg/L at SC-3 (Soda Mid), SC-4 (Soda Down), and SC-6 (Soda at the property line). The ROD specifies a selenium concentration of 0.05 mg/L for Soda Creek.

Groundwater in other portions of the Plant site (UBZ-3 and UBZ-4) is controlled by pumping of the Plant production wells and does not migrate offsite, or originates from non-Plant activity (Tronox site; formerly Kerr-McGee) and is not part of this Work Plan.



3.0 APPROACH

The USEPA requested that Monsanto install additional monitoring wells south of the southern boundary wells and west of the Plant to:

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- Define the downgradient extent of the UBZ-2 plume south of the Plant fenceline.
- Evaluate groundwater elevations and flow directions in the area between the southern boundary wells, the Monsanto southern property line, and Soda Creek.
- Evaluate the hydrogeologic conditions in UBZ-1 west and south of the Plant including the offset of the Subsidiary Fault on groundwater flow.
- Characterize shallow groundwater in the UBZ-1 immediately east of Soda Creek.
- Evaluate the vertical distribution of the constituents of concern in the UBZ-2 south of the Plant fenceline.
- Evaluate concentrations of constituents of concern south of the Plant fenceline to support the performance of monitored natural attenuation.

To meet these goals, the following approach is proposed:

- Interpretation of the hydrogeologic conditions in the UBZ-1 and UBZ-2 and identification of data gaps and uncertainties and potential well locations.
- Drill, install, and develop the monitoring wells and install dedicated sampling pumps in each new monitoring well.
- Test the monitoring wells, including rising head tests to determine the hydraulic conductivity of the particular interflow zone being monitored.
- Sample the wells to evaluate concentrations of the constituents of concern in groundwater.
- Interpret and report the results of the investigations.



4.0 FIELD INVESTIGATIONS

This section details the field methods and procedures to be followed during the location, construction, installation, development, and sampling of the new groundwater monitoring wells.

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4.1 Data Evaluation and Well Locations

The existing hydrogeologic data have been evaluated as part of the Phase II RI (Golder 1995), annual water quality reports prepared by Golder since 1998, Five-Year Review reports completed in 2003 and 2008 (Golder 2003, 2008), and as part of the revisions to the 2009 annual water quality report (CH2M Hill 2010; Golder 2010b). The evaluations indicated the following uncertainties with regard to the conceptual hydrogeologic model for UBZ-1 and UBZ-2:

- The southern extent of the UBZ-2 plume at the Monsanto property boundary cannot be determined with the existing monitoring well network.
- The hydrogeologic properties of the Subsidiary Fault north of the southern Plant fenceline and west of the Old UFS pond are uncertain.
- Groundwater quality in wells TW-60 and TW-61 suggests upwelling of deeper sodic groundwater is occurring in the UBZ-1 between Soda Creek and Government Dam Road. The presence and groundwater quality of shallow fresh groundwater occurring in this area is uncertain; shallow interflow zones were intersected above the screened interval and below the water table in both wells that contained a small amount of groundwater.
- The vertical distribution of the constituents of concern in the UBZ-2 plume south of the Plant Fenceline to the Monsanto property line is uncertain.

To address these uncertainties, additional monitoring wells are proposed. Potential well locations were summarized in Golder (2010a). The well locations were revised from the locations shown in Golder (2010a) following review by the USEPA (Mark Ader, USEPA, email communication to David Banton, Golder Associates Inc.). The revised proposed well locations are shown on Figure 3 and summarized in Table 1.

TW-63: Drilled adjacent to MW-61 to an approximate depth of 40 feet to evaluate shallow groundwater in the γ 5 zone in UBZ-1 east of Soda Creek.

TW-64: Drilled adjacent to MW-60 to an approximate depth of 40 feet to evaluate shallow groundwater in the γ 5 zone in UBZ-1 east of Soda Creek.

TW-65: Drilled near the southern Monsanto property line to an approximate depth of 40 feet to evaluate shallow groundwater quality in the γ 5 zone in UBZ-2.

TW-66: Drilled near the southern Monsanto property line adjacent to TW-65 to an approximate depth of 80 feet to evaluate deep groundwater quality in the γ 4 zone in UBZ-2.

TW-67: Drilled near the southern Monsanto property line to an approximate depth of 80 feet to evaluate deep groundwater quality in the γ 4 zone in UBZ-2.





TW-68: Drilled west of TW-22 and TW-24 on the west side of the Subsidiary Fault to an approximate depth of 80 feet to evaluate offset on the fault and groundwater conditions in the γ 4 zone in UBZ-1.

TW-69: Drilled west of TW-36 (decommissioned) on the west side of the Subsidiary Fault to an approximate depth of 80 feet to evaluate offset on the fault and groundwater conditions in the γ 4 zone in UBZ-1.

TW-70: Drilled adjacent to MW-62 (completed in the γ 4 interflow zone) to an approximate depth of 100 feet to evaluate the vertical distribution of the constituents of concern in the γ 3 interflow zone in UBZ-2.

TW-07 (Replacement Well): TW-07 appears to be blocked or kinked. An attempt will be made to install a 2-inch diameter screen and riser to facilitate installation of a temporary sampling pump or bailer. If the screen and riser cannot be installed in TW-07 to allow collection of groundwater quality samples, TW-07 will be decommissioned and a replacement well installed. TW-07 is 60 feet deep and completed in the γ 4 zone in UBZ-1 in the Southwest corner of the Plant (Figure 2).

Well TW-70 will be drilled, installed, and sampled first. If groundwater quality sampling at TW-70 indicates the $\gamma 3$ interflow zone in UBZ-2 is impacted by selenium or other constituents of concern at concentrations exceeding half the remedial goal (RG) concentration, an additional well will be installed in the $\gamma 3$ interflow zone south of TW-70 to characterize the vertical extent of groundwater contamination near the Monsanto property boundary. The location of this well, if needed, will be evaluated and proposed to USEPA prior to drilling.

4.2 Monitoring Well Installation

Monitoring wells will be installed at locations determined from the data review and access considerations (Figure 3). The wells will be installed in the first saturated interflow zone intersected during drilling (anticipated to be γ 4 for most wells) or in deeper zones depending on the well location and purpose (Table 1).

Monsanto will select a qualified drilling contractor to install the monitoring wells. Groundwater monitoring wells will be constructed in accordance with the Idaho Administrative Procedures Act for Well Construction Standards Rules (IDAPA 37.03.09; IAC 2010a), and in accordance with Golder Technical Procedures TP-1.2-5 for Drilling, Sampling, and Logging of Soils (Golder 1996a) and Technical Guideline TG-1.2-12 for Monitoring Well Drilling and Installation (Golder 2009b). Copies of the Idaho well construction regulations are included in Appendix A, and technical procedures for well installation, testing, and sampling are included in Appendix B for reference. Permits ("start cards") will be obtained from the Idaho Department of Water Resources (IDWR) prior to construction of the groundwater monitoring wells. The contractor will file well logs and any other required information with IDWR at the completion of drilling.





The boreholes for the monitoring wells will be drilled using an air-rotary drilling rig. Temporary casing will be used, if needed, to control borehole stability problems though interflow zones or unconsolidated surficial materials. The borehole diameter will be a minimum of 8-inches in order to install 4-inch diameter PVC monitoring wells. Formation samples (cuttings) will be collected every five feet or at formation changes and geologically logged during drilling. The following will be noted:

- Lithology
- Structure (fractured, dense, etc.)
- Depth(s) of groundwater-bearing zones intersected
- Water content (dry, damp, moist, wet)
- Air-lift flow rate in groundwater-bearing zones (if possible)
- Drilling action and zones of lost circulation, fracturing, changes in penetration rate, etc.
- Groundwater level at time of drilling, if possible to measure

Field groundwater quality parameters (temperature, pH and conductivity) will be periodically measured in groundwater airlifted from groundwater-bearing zones.

Drill cuttings and water will be discharged to the ground in the area of the well during drilling.

The monitoring wells will be completed using 4-inch diameter, flush-threaded, Schedule 40 PVC risers and well screens. The screened intervals in each well will be selected based on the intended purpose of the well and observations of groundwater occurrence and groundwater quality made during drilling. Centralizers will be placed on the top and bottom of the well screen, and at 40-foot intervals on the riser to centralize the well during installation. If necessary, the borehole will be backfilled below the selected screened section with 3/8-inch sodium bentonite chips or pellets to the desired completion interval. Wells will be completed with a silica sand filter pack, bentonite pellet seal, and a bentonite grout annular seal. Temporary casing (if used) will be withdrawn as the annular materials are placed. A locking protective monument, protective posts (if needed), and concrete pad will be installed following well completion. Typical monitoring well construction is shown on Figure 4. If a borehole is abandoned prior to well construction, it will be decommissioned in accordance with IDAPA 37.03.09.

A permanent measuring point will be designated on the top of each well riser or well seal. The new wells will be surveyed for location, ground elevation, and measuring point elevation (to the nearest 0.01 foot) following installation and will be tied into the current monitoring well network.

4.2.1 Drilling Water and Decontamination

Monsanto will designate a source of water (Production Well 4) to be used for drilling and borehole construction. Production Well 4 is located at the north end of the Plant and is not affected by Plant





activities. Water may be introduced during drilling if needed to reduce dust or assist in cuttings return. No other additives will be used during drilling.

All down-hole equipment (temporary drive casing, drill bits, samplers, drill rods, temporary pumps, airlift tools, bailers, and water level indicators) shall be thoroughly cleaned upon arrival at the site and between boreholes with a high-pressure, high temperature, jetted stream of potable water and an approved detergent (Alconox) followed by a clean rinse. Decontamination will be conducted at a decontamination area designated by Monsanto. Only approved drilling lubricants specifically designed for monitoring wells (vegetable oil-based or Teflon grease) will be used for all downhole equipment to prevent the introduction of petroleum hydrocarbons.

4.3 Well Development

Well development will be conducted after the well is completely installed, and prior to groundwater sampling and hydraulic testing. Initial development will be performed using air-lift pumping and surging methods following well installation. A permanent ½-hp submersible pump and dedicated riser and valve assembly will be installed in each well following air-lift development to further develop the well and for subsequent groundwater sample collection. Field water quality parameters (pH, specific conductance, turbidity, temperature, and dissolved oxygen) will be monitored throughout development. Well development will take place until water is free of material (e.g., cuttings and geologic materials), representative of formation water, and the turbidity is less than 5 NTU.

4.4 Rising Head Tests

Rising head tests will be completed in the new wells in order to estimate the hydraulic conductivity of the completion interval by displacing water in the well using a bailer or the dedicated pump and rapidly recording water levels as they recover. The well will be pumped at the maximum rate for 30 to 45 seconds using the sampling pump, or a slug of water will be removed with a bailer, and the water level recovery will be monitored using an automated pressure transducer and datalogger. Once the water level has re-equilibrated, a second test will be performed. The resulting data will be processed and analyzed using appropriate curve matching or straight-line methods.

Rising head tests will be conducted in accordance with Golder Technical Procedure TP 1.2-17 for Rising Head Slug Test (Golder 1986). A copy of TP 1.2-17 is included in Appendix B.

4.5 Groundwater Quality Sampling

A groundwater quality sample will be collected in all of the new monitoring wells following well development and rising head tests. The wells will be purged for a minimum of three well volumes, the turbidity is less than 5 NTU, and until field parameters (pH, conductivity, temperature, turbidity, and dissolved oxygen) are stable.



The groundwater quality samples will be collected and analyzed in accordance with procedures outlined in the Groundwater and Surface Water Sampling Work Plan (Golder 2011), Golder Technical Guideline TG-1.2-20 "Collection of Groundwater Quality Samples" (Golder 2009c) and Golder Technical Guideline TG-1.2-23 "Chain of Custody" (Golder 2009d). At least one duplicate sample and one split sample will be collected during sampling of the new wells. Table 2 summarizes the constituents that will be analyzed.

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The new monitoring wells will be included in the annual groundwater monitoring program.





5.0 SCHEDULE

Construction, testing, and sampling of the new groundwater monitoring wells will be scheduled to be completed in May or June 2011. The wells will be sampled following completion to permit an overall evaluation of the downgradient extent of the plume. The major components of the schedule include the following:

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- Work Plan (February 2011)
- Data evaluation and well locations (complete)
- Construct and develop wells (May and June 2011)
- Rising head tests and groundwater sampling (June 2011)
- Technical memorandum on well construction and testing (August 2011)
- Reporting of groundwater quality results including new wells and the 2011 annual groundwater sampling (November and December 2011)

Table 1: Proposed Monitoring Well Information

Well Number	Latitude	Longitude	Approximate Depth (feet)	Completion Horizon	Purpose and Notes
TW-63	42.672635	-111.594831	40	γ5	Adjacent to TW-61, shallow groundwater quality
TW-64	42.669805	-111.594939	40	γ5	Adjacent to TW-60, shallow groundwater quality
TW-65	42.66345	-111.5921	40	γ5	South end of property, shallow sentinel well
TW-66	42.66345	-111.59921	80	γ4	South end of property, deep sentinel well
TW-67	42.663374	-111.588643	80	γ4	South end of property, deep sentinel well
TW-68	42.684321	-111.596759	80	γ4	Opposite TW-22/24, UBZ-1 groundwater conditions
TW-69	42.68005	-111.594934	80	γ4	Opposite TW-36, UBZ-1 groundwater conditions
TW-70	42.672031	-111.590014	100	γ3	Adjacent to TW-62, evaluate γ3 groundwater conditions

Note:

Well depths are approximate and will be determined based on observed geologic and groundwater conditions during drilling.



Table 2: Analytical Constituents, Preservatives, Holding Times, and Analytical Methods

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Analytical Constituents	Preservative	Holding Time	Analytical Methods		
Total Metals			•		
Cadmium	Cool, 4°C: HNO3 to pH<2	6 months	6010B		
Calcium	Cool, 4°C: HNO3 to pH<2	6 months	6010B		
Magnesium	Cool, 4°C: HNO3 to pH<2	6 months	6010B		
Manganese	Cool, 4°C: HNO3 to pH<2	6 months	6010B		
Molybdenum	Cool, 4°C: HNO3 to pH<2	6 months	6010B		
Potassium	Cool, 4°C: HNO3 to pH<2	6 months	6010B		
Selenium	Cool, 4°C: HNO3 to pH<2	6 months	ICAP with hydride generation ^a		
Sodium	Cool, 4°C: HNO3 to pH<2	6 months	6010B		
Vanadium	Cool, 4°C: HNO3 to pH<2	6 months	6010B		
Zinc	Cool, 4°C: HNO3 to pH<2	6 months	6010B		
Other lons					
Total Alkalinity (as CaCO ₃)	Cool, 4°C	14 days	2320B		
Ammonia and Ammonium as N	Cool, 4°C; H2SO4 to pH<2	28 days	350.1		
Chloride	Cool, 4°C	28 days	300		
Fluoride	Cool, 4°C	28 days	300		
Nitrate and Nitrite As N	Cool, 4°C; H2SO4 to pH<2	28 days	353.2		
Total Phosphorus	Cool, 4°C; H2SO4 to pH<2	28 days	365.2		
Sulfate	Cool, 4°C	28 days	300		
TDS	Cool, 4°C	7 days	160.1		
Hardness (as CaCO ₃)	Cool, 4°C: HNO3 to pH<2	6 months	2340B		
Field Parameters					
Conductivity	None required	None required	None required		
Dissolved Oxygen	None required	None required	None required		
рН	None required	None required	None required		
Turbidity	None required	None required	None required		
Temperature	None required	None required	None required		

Notes

a. 6010B and 7741A



6.0 CLOSING

GOLDER ASSOCIATES INC.

David Banton, LHG, RG Principal Hydrogeologist

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Michael Klisch, LHG Senior Project Hydrogeologist

Michael Kist





7.0 REFERENCES

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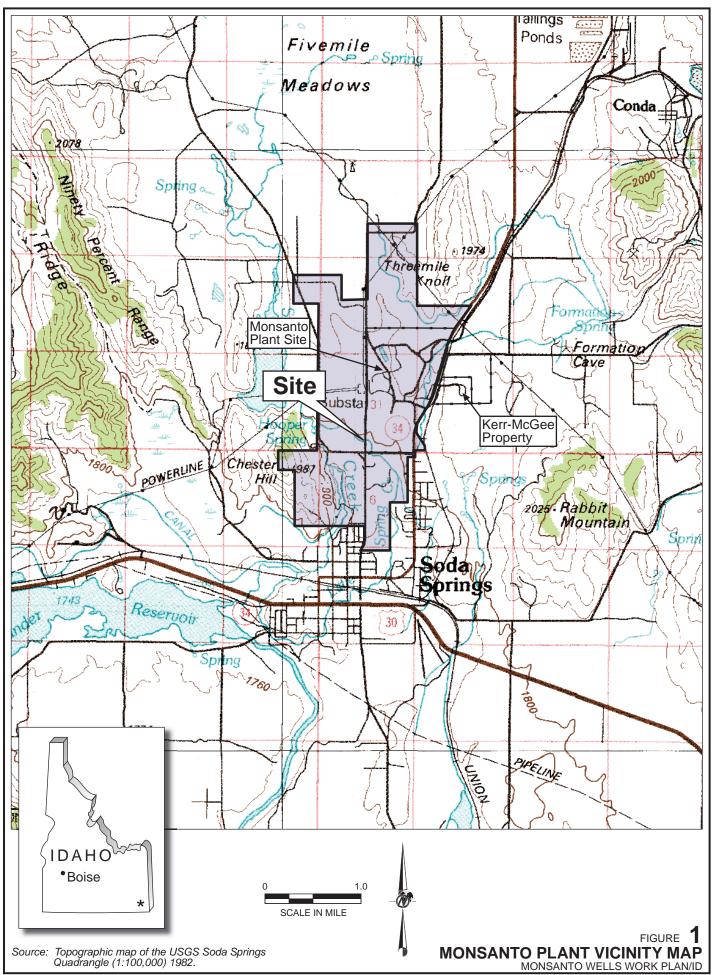


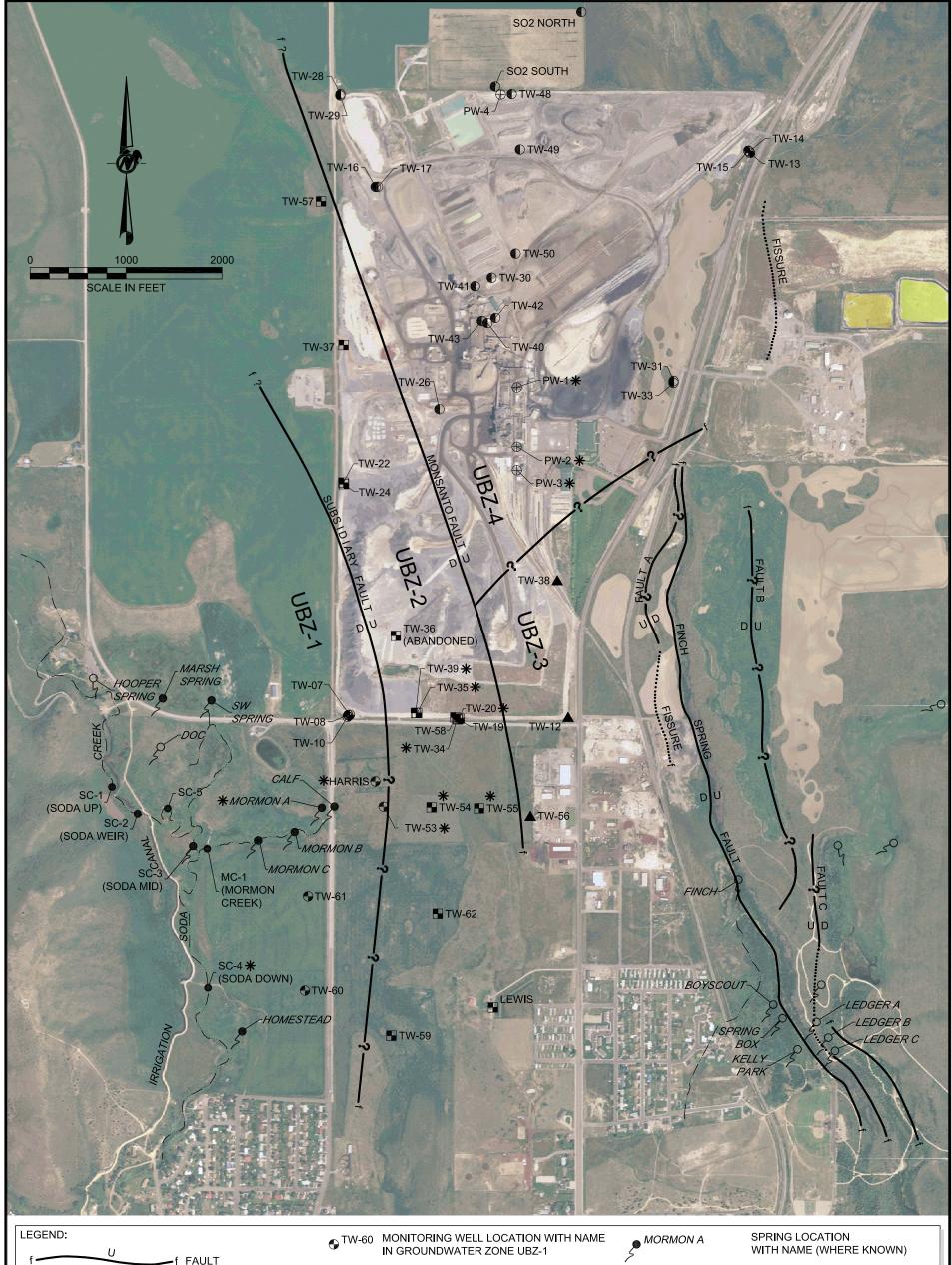
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- Idaho Administrative Code (IAC). 2010a. Well Construction Standards Rules (IDAPA 37.03.09), Department of Water Resources, Idaho.

IAC. 2010b. Water Quality Standards, (IDAPA 58.01.02).









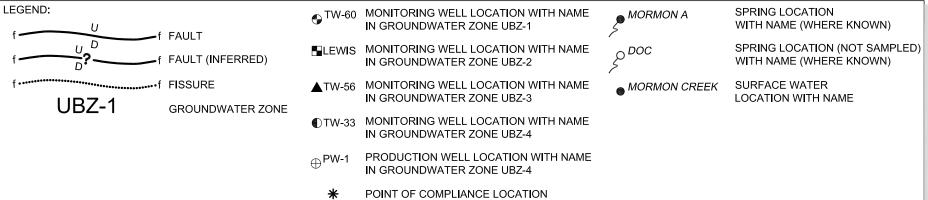
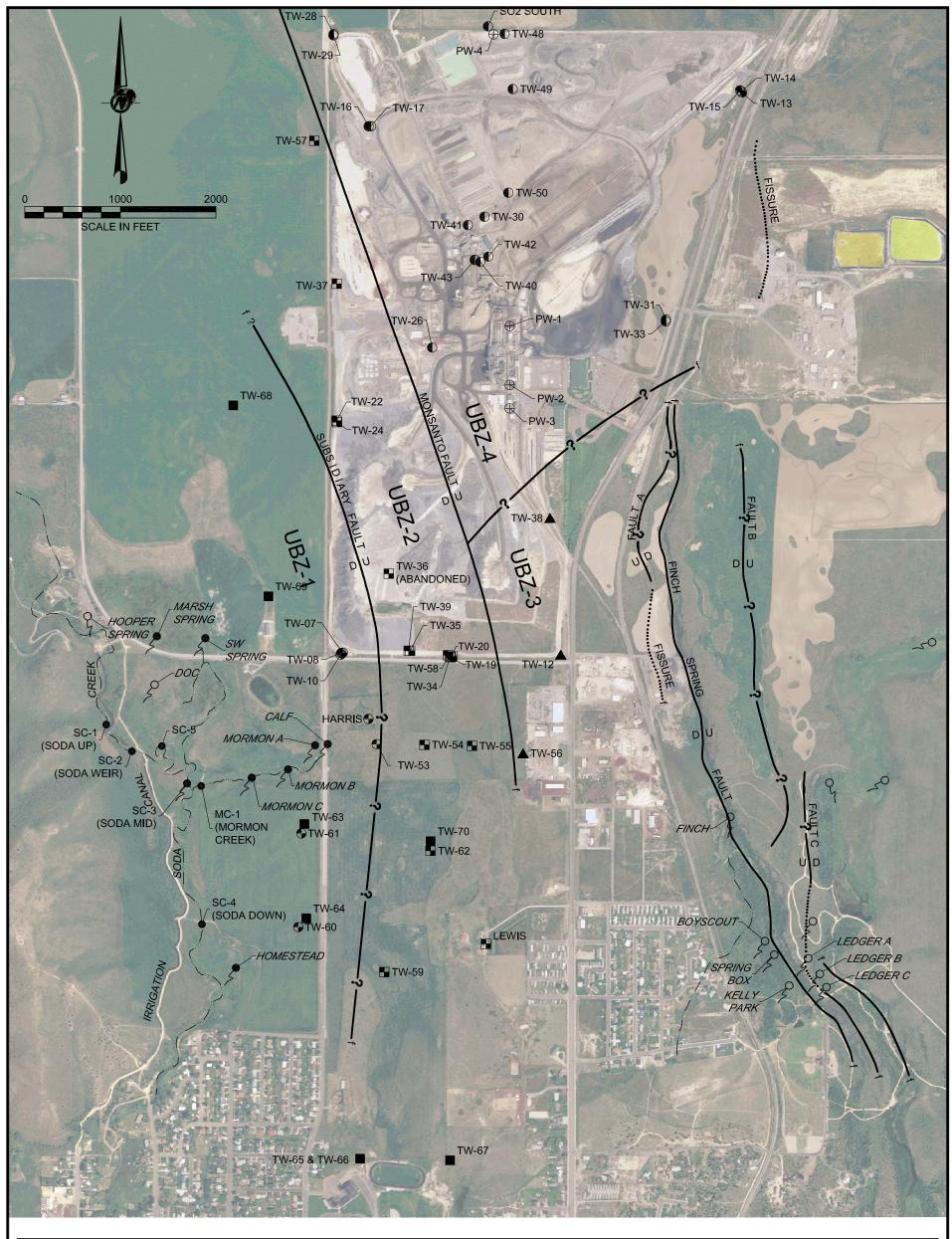
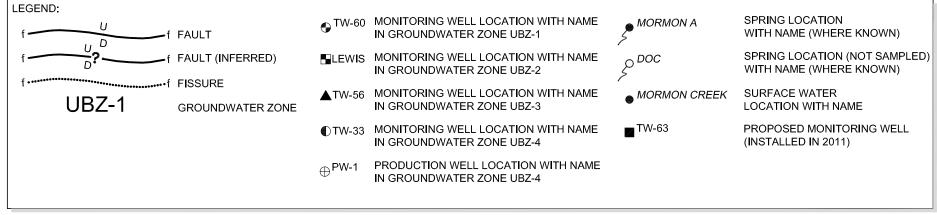


FIGURE 2

LOCATION OF SPRINGS AND WELLS IN THE UPPER BASALT ZONE

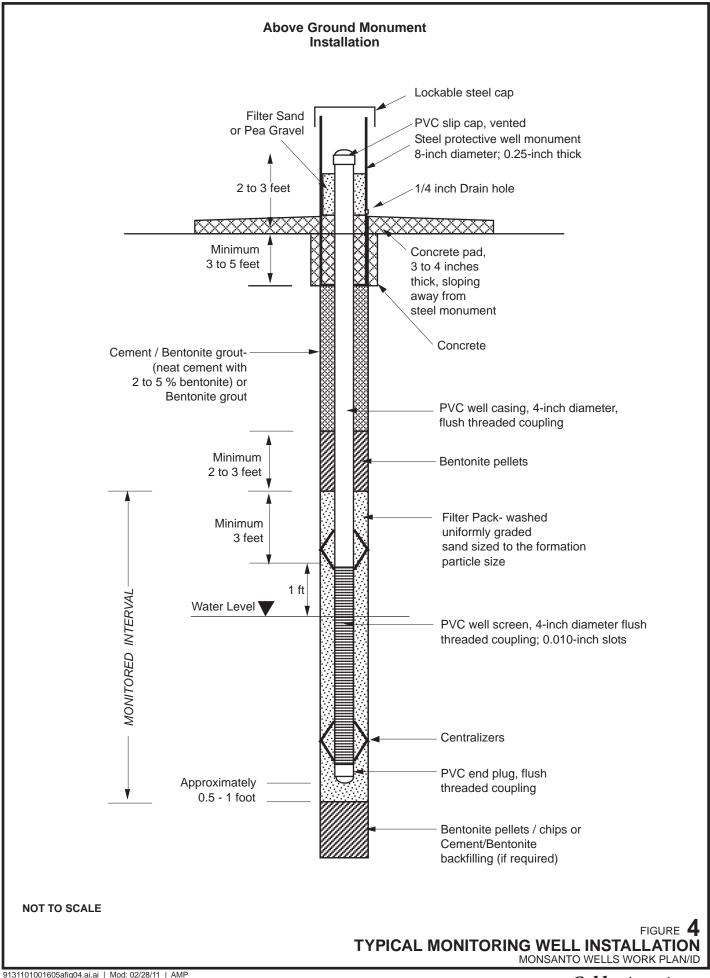
MONITORING WELLS WORK PLAN





SOURCE: AERIAL PHOTO FROM MONSANTO (5/2/2003). SITE TOPOGRAPHY FROM AERIAL MAPPING, INC., IDAHO (5/11/1996). PROPOSED MONITORING WELL LOCATIONS

MONITORING WELL WORK PLAN



APPENDIX A
STATE OF IDAHO MONITORING WELL CONSTRUCTION REGULATIONS

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37.03.09 - Well Construction Standards Rules

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IDAPA 37 TITLE 03 CHAPTER 09

37.03.09 - WELL CONSTRUCTION STANDARDS RULES

000. LEGAL AUTHORITY (RULE 0).

The Idaho Water Resource Board adopts these administrative rules with the authority provided by Section 42-238(12), Idaho Code. (5-8-09)

001. TITLE AND SCOPE (RULE 1).

- **01. Title.** These rules are cited as IDAPA 37.03.09, "Well Construction Standards Rules." (5-8-09)
- **O2. Scope.** The Department of Water Resources has statutory responsibility for the statewide administration of the rules governing well construction. These rules establish minimum standards for the construction of all new wells and the modification and decommissioning (abandonment) of existing wells. The intent of the rules is to protect the ground water resources of the state against waste and contamination. These rules are applicable to all water wells, monitoring wells, low temperature geothermal wells, injection wells, cathodic protection wells, closed loop heat exchange wells, and other artificial openings and excavations in the ground that are more than eighteen (18) feet in vertical depth below land surface as described in these rules pursuant to Section 42-230 Idaho Code. Some artificial openings and excavations do not constitute a well. For the purposes of these rules, artificial openings and excavations not defined as wells are described in Subsection 045.03 of these rules. Any time that such an artificial opening or excavation is constructed, modified, or decommissioned (abandoned) the intent of these rules must be observed. If waste or contamination is attributable to this type of artificial opening or excavation, the artificial opening or excavation must be modified, or decommissioned (abandoned) as determined by the Director. (5-8-09)

002. WRITTEN INTERPRETATION (RULE 2).

In accordance with Section 67-5201(19)(b)(iv), Idaho Code, the Idaho Department of Water Resources may draft and implement written statements that pertain to the interpretation of these rules, or to the documentation of compliance with these rules.

(5-8-09)

003. ADMINISTRATIVE APPEALS (RULE 3).

Persons may be entitled to appeal agency actions authorized under these rules pursuant to Section 42-1701A, Idaho Code, and IDAPA 37.01.01, "Rules of Procedure of the Idaho Department of Water Resources" (5-8-09)

004. INCORPORATION BY REFERENCE (RULE 4).

No documents have been incorporated by reference into this chapter.

(5-8-09)

005. OFFICE HOURS -- MAILING ADDRESS AND STREET ADDRESS (RULE 5).

- **01. Office Hours**. Office hours are 8 a.m. to 5 p.m. local time, Monday through Friday, except holidays designated by the state of Idaho. (5-8-09)
- **02. Mailing Address**. The mailing address for the state office is: Idaho Department of Water Resources, P.O. Box 83720, Boise, Idaho 83720-0098. (5-8-09)
- **03. Street Address**. The street addresses for the state office of the Department of Water Resources, the regional offices in Idaho Falls, Coeur d'Alene, Twin Falls, and Boise, and the satellite offices in Salmon, and Soda Springs may be obtained by calling the state office at (208) 287-4800, or by visiting the Department's website at http://www.idwr.idaho.gov. (5-8-09)

006. PUBLIC RECORDS ACT COMPLIANCE (RULE 6).

Records maintained by the Department of Water Resources are subject to the provisions of the Idaho Public Records Act, Title 9, Chapter 3, Sections 9-337 through 9-349, Idaho Code. (5-8-09)

007. -- 009. (RESERVED).

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010. DEFINITIONS (RULE 10).

Unless the context otherwise requires, the following definitions apply to these rules.

(5-8-09)

- **01. Approved Seal or Seal Material**. Seal material must consist of bentonite chips, pellets, or granules, bentonite grout, neat cement, or neat cement grout as defined by these rules. No other materials may be used unless specifically authorized by the Director (5-8-09)
- **02. Annular Space**. The space, measured as one-half (1/2) the difference in diameter between two (2) concentric cylindrical objects, one of which surrounds the other, such as the space between the walls of a drilled hole (borehole) and a casing or the space between two (2) strings of casing. (5-8-09)
- **03. Aquifer.** Any geologic formation(s) that will yield water to a well in sufficient quantities to make the production of water from the formation feasible for beneficial use. (5-8-09)
- **04. Area of Drilling Concern**. An area designated by the Director in which drillers must comply with additional standards to prevent waste or contamination of ground or surface water due to such factors as aquifer pressure, vertical depth of the aquifer, warm or hot ground water, or contaminated ground or surface waters, in accordance with Section 42-238(7), Idaho Code. (5-8-09)
- **05. Artesian Water**. Any water that is confined in an aquifer under pressure so that the water will rise in the well casing or drilled hole above the elevation where it was first encountered. This term includes water of flowing and non-flowing wells. (5-8-09)
- **06. Artificial Filter Pack**. Clean, rounded, smooth, uniform, sand or gravel placed in the annular space around a perforated well casing or well screen. A filter pack is frequently used to prevent the movement of finer material into the well casing and to increase well efficiency. (5-8-09)
- **07. Bentonite.** A commercially processed and packaged, low permeability, sodium montmorillonite clay certified by the NSF International for use in well construction, sealing, plugging, and decommissioning (abandonment). All bentonite products used in the construction or decommissioning (abandoning) of wells must have a permeability rating not greater than 10^{-7} (ten to the minus seven) cm/sec. (5-8-09)
- **a.** Chips. Bentonite composed of pieces ranging in size from one-quarter (1/4)-inch to one (1) inch on their greatest dimension. (5-8-09)
- **b.** Granules (also Granular). Bentonite composed of pieces ranging in size from one thirty-seconds (1/32) inch (#20 standard mesh) to seven thirty-seconds (7/32) inch (#3 standard mesh) on their greatest dimension. (5-8-09)
- **c.** Bentonite Grout. A mixture of bentonite specifically manufactured for use as a well sealing or plugging material and potable water to produce a grout with an active solids content not less than twenty-five percent (25%) by weight e.g., (twenty-five percent (25%) solids content by weight = fifty (50) pounds bentonite per eighteen (18) gallons of water). (5-8-09)
- **d.** Pellets. Bentonite manufactured for a specific purpose and composed of uniform sized, one-quarter (1/4) inch, three-eighths (3/8) inch, or one-half (1/2) inch pieces on their greatest dimension. (5-8-09)
 - **08.** Board. The Idaho Water Resource Board. (7-1-93)
 - **O9. Bore Diameter.** The diameter of the hole in the formation made by the drill bit or reamer. (7-1-93)
 - **10. Borehole (also Well Bore).** The subsurface hole created during the drilling process. (5-8-09)
- 11. Bottom Hole Temperature of an Existing or Proposed Well. The temperature of the ground water encountered in the bottom of a well or borehole. (5-8-09)

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- 12. Casing. The permanent conduit installed in a well to provide physical stabilization, prevent caving or collapse of the borehole, maintain the well opening and serve as a solid inner barrier to allow for the installation of an annular seal. Casing does not include temporary surface casing, well screens, liners, or perforated casing as otherwise defined by these rules. (5-8-09)
- **13. Cathodic Protection Well**. Any artificial excavation in excess of eighteen (18) feet in vertical depth constructed for the purpose of protecting certain metallic equipment in contact with the ground. Commonly referred to as cathodic protection. (7-1-93)
- 14. Closed Loop Heat Exchange Well. A ground source thermal exchange well constructed for the purpose of installing any underground system through which fluids are circulated but remain isolated from direct contact with the subsurface or ground water. (5-8-09)
- **15. Conductor Pipe**. The first and largest diameter string of permanent casing to be installed in a low temperature geothermal resource well. (5-8-09)
- **16. Confining Layer.** A subsurface zone of low-permeability earth material that naturally acts to restrict or retard the movement of water or contaminants from one zone to another. The term does not include topsoil. (5-8-09)
- 17. Consolidated Formations. Naturally-occurring geologic formations that have been lithified (turned to stone) such as sandstone and limestone, or igneous rocks such as basalt and rhyolite, and metamorphic rocks such as gneiss and slate. (5-8-09)
- **18. Contaminant**. Any physical, chemical, ion, radionuclide, synthetic organic compound, microorganism, waste, or other substance that does not occur naturally in ground water or that naturally occurs at a lower concentration. (5-8-09)
- **19. Contamination**. The introduction into the natural ground water of any physical, chemical, biological or radioactive material that may: (7-1-93)
 - **a.** Cause a violation of Idaho Ground Water Quality Standards; or (5-8-09)
 - **b.** Adversely affect the health of the public; or (7-1-93)
- c. Adversely affect a designated or beneficial use of the State's ground water. Contamination includes the introduction of heated or cooled water into the subsurface that will alter the ground water temperature and render the local ground water less suitable for beneficial use, or the introduction of any contaminant that may cause a violation of IDAPA 58.01.11, "Ground Water Quality Rule." (5-8-09)
- **20. Decommissioned (Abandoned) Well**. Any well that has been permanently removed from service and filled or plugged in accordance with these rules so as to meet the intent of these rules. A properly decommissioned well will not: (5-8-09)
 - **a.** Produce or accept fluids; (5-8-09)
 - **b.** Serve as a conduit for the movement of contaminants inside or outside the well casing; or (5-8-09)
- **c.** Allow the movement of surface or ground water into unsaturated zones, into another aquifer, or between aquifers. (5-8-09)
- **21. Decontamination**. The process of cleaning equipment intended for use in a well in order to prevent the introduction of contaminants into the subsurface and contamination of natural ground water. (5-8-09)
 - **22. Department**. The Idaho Department of Water Resources. (7-1-93)

- **23. Dewatering Well**. A well constructed for the purpose of improving slope stability, drying up borrow pits, or intercepting seepage that would otherwise enter an excavation. (5-8-09)
- **24. Director**. The Director of the Idaho Department of Water Resources or his duly authorized representatives. (7-1-93)
- **25. Disinfection.** The introduction of chlorine or other agent or process approved by the Director in sufficient concentration and for the time required to inactivate or kill fecal and Coliform bacteria, indicator organisms, and other potentially harmful pathogens. (5-8-09)
- **26. Draw Down**. The difference in vertical distance between the static water level and the pumping water level. (5-8-09)
- **27. Drive Point (also known as a Sand Point)**. A conduit pipe or casing through which ground water of any temperature is sought or encountered created by joining a "drive point unit" to a length of pipe and driving the assembly into the ground. (5-8-09)
- **28. Exploratory Well.** A well drilled for the purpose of discovering or locating new resources in unproven areas. They are used to extract geological, hydrological, or geophysical information about an area. (5-8-09)
- **29. Global Positioning System (GPS)**. A global navigational receiver unit and satellite system used to triangulate a geographic position. (5-8-09)
 - **30. Hydraulic Conductivity.** A measurement of permeability. (5-8-09)
- **31. Hydraulic Fracturing.** A process whereby water or other fluid is pumped under high pressure into a well to further fracture the reservoir rock or aquifer surrounding the production zone of a well to increase well yield. (5-8-09)
- **32. Injection Well**. Any excavation or artificial opening into the ground which meets the following three (3) criteria: (7-1-93)
 - **a.** It is a bored, drilled or dug hole, or is a driven mine shaft or driven well point; and (7-1-93)
 - **b.** It is deeper than its largest straight-line surface dimension; and (7-1-93)
 - **c.** It is used for or intended to be used for subsurface placement of fluids. (7-1-93)
- 33. Intermediate String or Casing. The casing installed and sealed below the surface casing within a low temperature geothermal resource well to isolate undesirable water or zones below the bottom of the surface casing. Such strings may either be lapped into the surface casing or extend to land surface. (5-8-09)
 - **34.** Liner. (5-8-09)
- **a.** A conduit pipe that can be removed from the borehole or well that is used to serve as access and protective housing for pumping equipment and provide a pathway for the upward flow of water within the well.

 (5-8-09)
- **b.** Liner does not include casing required to prevent caving or collapse, or both, of the borehole or serve as a solid inner barrier to allow for the installation of an annular seal. (5-8-09)
- **35. Mineralized Water.** Any naturally-occurring ground water that has an unusually high amount of chemical constituents dissolved within the water. Water with five thousand (5000) mg/L or greater total dissolved solids is considered mineralized. (5-8-09)
 - **36.** Modify. To deepen a well, increase or decrease the diameter of the casing or the well bore, install a

liner, place a screen, perforate existing casing or liner, alter the seal between the casing and well bore, or alter the well to not meet well construction standards. (5-8-09)

- **37. Monitoring Well**. Any well more than eighteen (18) feet in vertical depth constructed to evaluate, observe or determine the quality, quantity, temperature, pressure or other characteristics of the ground water or aquifer. (7-1-93)
- **38. Neat Cement.** A mixture of water and cement in the ratio of not more than six (6) gallons of water to ninety-four (94) pounds of Portland cement (neat cement). Other cement grout mixes may be used if specifically approved by the Director. (5-8-09)
- **39. Neat Cement Grout.** Up to five percent (5%) bentonite by dry weight may be added per sack of cement (neat cement grout) and the water increased to not more than six and one-half (6.5) gallons per sack of cement. Other neat cement mixes may be used if specifically approved by the Director. These grouts must be mixed and installed in accordance with the American Petroleum Institute Standards API Class A through H. As found in API RP10B, "Recommended Practice for Testing Oil Well Cements and Cement Additives," current edition or other approved standards.

 (5-8-09)
- **40. Oxidized Sediments.** Sediments, characterized by distinct coloration, typically shades of brown, red, or tan, caused by the alteration of certain minerals in an environment with a relative abundance of oxygen.

 (5-8-09)
- **41. Perforated Well Casing.** Well casing that has been modified by the addition of openings created by drilling, torch cutting, saw cutting, mechanical down-hole perforator, or other method. (5-8-09)
- **42. Pitless Adaptor or Pitless Unit.** An assembly of parts designed for attachment to a well casing which allows buried pipe to convey water from the well or pump and allows access to the interior of the well casing for installation or removal of the pump or pump appurtenances, while maintaining a water tight connection through the well casing and preventing contaminants from entering the well. (5-8-09)
 - **43. Potable Water.** Water of adequate quality for human consumption. (5-8-09)
- 44. **Pressure Grouting (Grouting)**. The process of pumping and placing an approved grout mixture into the required annular space, by positive displacement from bottom to top using a tremie pipe, Halliburton method, float shoe, or other method approved by the Director. (5-8-09)
- **45. Production Casing.** The casing or tubing through which a low temperature geothermal resource is produced. This string extends from the producing zone to land surface. (5-8-09)
- **46. Public Water System.** A system for the provision to the public of water for human consumption through pipes or, after August 5, 1998, other constructed conveyances, if such system has at least fifteen (15) service connections, regardless of the number of water sources or configuration of the distribution system, or regularly serves an average of at least twenty-five (25) individuals daily at least sixty (60) days out of the year. Such term includes: (5-8-09)
- **a.** Any collection, treatment, storage, and distribution facilities under the control of the operator of such system and used primarily in connection with such system; and (5-8-09)
- **b.** Any collection or pretreatment storage facilities not under such control that are used primarily in connection with such system. (5-8-09)
 - **c.** Such term does not include any "special irrigation district." (5-8-09)
 - **d.** A public water system is either a "community water system" or a "non-community water system." (5-8-09)
 - 47. Reduced Sediments. Sediments, characterized by distinct coloration, typically shades of blue,

black, gray, or green, caused by the alteration of certain minerals in an oxygen poor environment.

(5-8-09)

- **48. Remediation Well.** A well used to inject or withdraw fluids, vapor, or other solutions approved by the Director for the purposes of remediating, enhancing quality, or controlling potential or known contamination. Remediation wells include those used for air sparging, vapor extraction, or injection of chemicals for remediation or in-situ treatment of contaminated sites. (5-8-09)
- **49. Sand**. Any sediment particle retained on a U.S. standard sieve #200 (Seventy-five hundreths (0.075) mm to two (2) mm). (5-8-09)
- **50. Screen (Well Screen)**. A commercially produced structural tubular retainer with standard sized openings to facilitate production of sand free water. (5-8-09)
- Seal or Sealing. The placement of approved seal material in the required annular space between a borehole and casing, between casing strings, or as otherwise required to create a low permeability barrier and prevent movement or exchange of fluids. Seals are required in the construction of new wells, repair of existing wells, and in the decommissioning (abandonment) of wells. Seals are essential to the prevention of waste and contamination of ground water.

 (5-8-09)
- **52. Start Card**. An expedited drilling permit process for the construction of cold water, single-family residential wells. (5-8-09)
 - 53. Static Water Level. The height at which water will rise in a well under non-pumping conditions.
- **54. Surface Casing.** The first string of casing in a low temperature geothermal resource well which is set and sealed after the conductor pipe to anchor blow out prevention equipment and to case and seal out all existing cold ground water zones. (5-8-09)
- **55. Temporary Surface Casing.** Steel pipe used to support the borehole within unstable or unconsolidated formations during construction of a well that will be removed following the installation of the permanent well casing and prior to or during placement of an annular seal. (5-8-09)
- **56. Thermoplastic/PVC Casing.** Plastic piping material meeting the requirements of ASTM F 480 and specifically designed for use as well casing. (5-8-09)
 - **Transmissivity**. The capacity of an aquifer to transmit water through its entire saturated thickness. (5-8-09)
- **58. Tremie Pipe**. A small-diameter pipe used to convey grout, dry bentonite products, or filter pack materials into the annular space, borehole, or well from the bottom to the top of a borehole or well. (5-8-09)
- **59. Unconfined Aquifer.** An aquifer in which the water table is in contact with and influenced by atmospheric pressure through pore spaces in the overlying formation(s). (5-8-09)
- **60. Unconsolidated Formation**. A naturally-occurring earth formation that has not been lithified. Alluvium, soil, sand, gravel, clay, and overburden are some of the terms used to describe this type of formation. (7-1-93)
- 61. Unstable Unit. Unconsolidated formations, and those portions of consolidated formations, that are not sufficiently hard or durable enough to sustain an open borehole without caving or producing obstructions without the aid of fluid hydraulics or other means of chemical or physical stabilization. (5-8-09)
- **62. Unusable Well**. Any well that can not be used for its intended purpose or other beneficial use authorized by law. (5-8-09)
 - **63.** Waiver. Approval in writing by the Director of a written request from the well driller and the well

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owner proposing specific variance from the minimum well construction standards.

(5-8-09)

- **64. Waste**. The loss, transfer, or subsurface exchange of a ground water resource, thermal characteristic, or natural artesian pressure from any aquifer caused by improper construction, misuse, or failure to properly maintain a well. Waste includes: (5-8-09)
 - a. The flow of water from an aquifer into an unsaturated subsurface zone; (5-8-09)
 - **b.** The transfer or mixing, or both, of waters from one aquifer to another (aquifer commingling); or (5-8-09)
- **c.** The release of ground water to the land surface whenever such release does not comply with an authorized beneficial use. (5-8-09)
- **65. Water Table**. The height at which water will rise in a well; also the upper surface of the zone of saturation in an unconfined aquifer. This level will change over time due to changes in water supply and aquifer impacts. (5-8-09)

66. Well. (5-8-09)

- a. An artificial excavation or opening in the ground more than eighteen (18) feet in vertical depth below land surface by which ground water of any temperature is sought or obtained. The depth of a well is determined by measuring the maximum vertical distance between the land surface and the deepest portion of the well. Any water encountered in the well is considered to be obtained for the purpose of these rules; or (5-8-09)
 - **b.** Any waste disposal and injection well, as defined in Section 42-3902, Idaho Code. (5-8-09)
 - c. Well does not mean: (5-8-09)
 - i. A hole drilled for mineral exploration; or (5-8-09)
- ii. Holes drilled for oil and gas exploration which are subject to the requirements of Section 47-320, Idaho Code; or (5-8-09)
 - iii. Holes drilled for the purpose of collecting soil samples above the water table. (5-8-09)
- **67. Well Development**. The act of bailing, jetting, pumping, or surging water in a well to remove drilling fluids, fines, and suspended materials from within a completed well and production zone in order to establish the optimal hydraulic connection between the well and the aquifer. (5-8-09)
- **68. Well Driller or Driller.** Any person who operates drilling equipment, or who controls or supervises the construction of a well, and is licensed under Section 42-238, Idaho Code (5-8-09)
- **69. Well Drilling or Drilling.** The act of constructing a new well or modifying or changing the construction of an existing well. (5-8-09)
- **70. Well Owner**. Any person, firm, partnership, co-partnership, corporation, association, or other entity, or any combination of these, who owns the property on which the well is or will be located or has secured ownership of the well by means of a deed, covenant, contract, easement, or other enforceable legal instrument for the purpose of benefiting from the well. (5-8-09)
- 71. Well Rig (Drill Rig). Any power driven percussion, rotary, boring, digging, jetting or auguring machine used in the construction of a well. (5-8-09)
- 011. -- 024. (RESERVED).
- 025. CONSTRUCTION OF COLD WATER WELLS (RULE 25).

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All persons constructing wells must comply with the requirements of Section 42-238, Idaho Code, and IDAPA 37.03.10, "Well Driller Licensing Rules." The standards specified in Rule 25 apply to all wells with a bottom hole temperature of eighty-five (85) degrees Fahrenheit or less. Wells with a bottom hole temperature greater than eighty-five (85) degrees Fahrenheit, but less than two hundred twelve (212) degrees Fahrenheit, must meet the requirements of Rule 30 in addition to meeting the requirements of Rule 25. These standards also apply to any waste disposal and injection well as defined in Section 42-3902, Idaho Code.

(5-8-09)

01. General. The well driller must construct each well as follows:

(5-8-09)

- a. In accordance with these rules and with the conditions of approval of any drilling permit issued pursuant Section 42-235, Idaho Code, and in a manner that will prevent waste and contamination of the ground water resources of the state of Idaho. The adopted standards are minimum standards which must be adhered to in the construction of all new wells, and in the modification or decommissioning (abandonment) of existing wells. The well driller is charged with the responsibility of preventing waste or contamination of the ground water resources during the construction, modification or abandonment of a well. The Director may add conditions of approval to a drilling permit issued pursuant to Rule 45 of these rules to require that a well be constructed, modified, or decommissioned (abandoned) in accordance with additional standards when necessary to protect ground water resources and the public health and safety from existing contamination and waste or contamination during the construction, modification or decommissioning (abandonment) of a well.

 (5-8-09)
- **b.** In consideration of the geologic and ground water conditions known to exist or anticipated at the well site. (5-8-09)
- **c.** Such that it is capable of producing, where obtainable, the quantity of water to support the allowed or approved beneficial use of the well, subject to law; (5-8-09)
- **d.** Meet the siting and separation distance requirements in the table in this Subsection (025.01.d.). Additional siting and separation distance requirements are set forth by the governing district health department and the Idaho Department of Environmental Quality rules at IDAPA 58.01.03, "Individual/Subsurface Sewage Disposal Rules," and IDAPA 58.01.08, "Idaho Rules for Public Drinking Water Systems".

Separation of Well from:	Minimum Separation Distance (feet)		
Existing Public Water Supply well, separate ownership	-	50	
Other existing well, separate ownership	-	25	
Septic drain field	-	100	
Septic tank	-	50	
Drainfield of system with more than 2,500 GPD of sewage inflow	-	300*	
Sewer line - main line or sub-main, pressurized, from multiple sources	-	100	
Sewer line - main line or sub-main, gravity, from multiple sources	-	50	
Sewer line - secondary, pressure tested, from a single residence or building	-	25	
Effluent pipe	-	50	
Property line	-	5	
Permanent buildings, other than those to house the well or plumbing apparatus, or both	-	10	
Above ground chemical storage tanks	-	20	
Permanent (more than six months) or intermittent (more than two months) surface water	-	50	

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Separation of Well from:	So	Minimum Separation Distance (feet)		
Canals, irrigation ditches or laterals, & other temporary (less than two months) surface water	-	25		
*This distance may be less if data from a site investigation demonstrates compliance with IDAPA 58.01.03, "Individual/Subsurface Sewage Disposal Rules," separation distances.				

(5-8-09)

02. Waivers. In unique cases where the Director concludes that the ground water resources will be protected against waste and contamination and the public health and safety are not compromised, a waiver of specific standards required by these rules may be approved prior to constructing, decommissioning, or modifying a well.

(5-8-09)

(5-8-09)

- **a.** To request a waiver the well driller and well owner must:
- i. Jointly submit a detailed plan and written request identifying a specific Rule or Rules proposed to be waived. Additionally, the plan must detail the well construction process that will be employed in lieu of complete Rule compliance: (5-8-09)
- ii. Prior to submittal, the well driller and the well owner must sign the plan and written request acknowledging concurrence with the request; and (5-8-09)
 - iii. Submit the plan and request by facsimile, e-mail, or letter. (5-8-09)
- **b.** The Director will evaluate and respond to the request within ten (10) business days of receiving the request. (5-8-09)
- i. If the request for waiver is approved, the intent of the rules will be served and all standards not waived will apply. Waivers approved by the Director will not supersede requirements of other regulatory agencies without specific concurrence from that agency. Work activity related to a waiver request will not proceed until a written or verbal approval is granted by the Director. (5-8-09)
 - ii. Any verbal approval will be followed by a written approval. (5-8-09)
- **Q3. Records.** In order to enable a comprehensive survey of the extent and occurrence of the state's ground water resource, the coordinates of every newly constructed, modified or decommissioned (abandoned) well location must be identified by latitude and longitude with a global positioning system (GPS) and recorded on the driller's report in degrees and decimal minutes and within the nearest 40 acre parcel using the Public Land Survey System. Every well driller must maintain records as described in IDAPA 37.03.10 "Well Driller Licensing Rules," pursuant to Section 42-238(11), Idaho Code, and provide the well owner with a copy of the approved well drilling permit and a copy of the well driller's report when submitted to the Director. (5-8-09)
- **O4.** Casing. The well driller must install casing in every well. Steel or thermoplastic casing may be installed in any well with a bottom hole temperature of eighty-five (85) degrees Fahrenheit or less. Thermoplastic pipe must not be installed in a well with a bottom hole temperature greater than eighty-five (85) degrees Fahrenheit. All casing to be installed must be new or in like-new condition, free of defects, and clearly marked by the manufacturer with all specifications required by these rules. For all wells the casing must extend at least twelve (12) inches above land surface and finished grade and to a minimum depth below land surface as required by these rules. Concrete slabs around a well casing will be considered finished grade (Figure 01, Appendix A). The well driller must install casing of sufficient strength to withstand calculated and anticipated subsurface forces and corrosive effects. The well driller must install casings sufficiently plumb and straight to allow the installation or removal of screens, liners, pumps and pump columns without causing adverse effects on the operation of the installed pumping

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equipment. (5-8-09)

- a. Steel Casing. When steel casing lengths are joined together, they must be joined by welded joints or screw-couple joints. All connection must be water tight. If steel casing joints are welded, the weld must be at least as thick as the well casing and fully penetrating. Welding rods or flux core wire of at least equal quality to the casing metal must be used. Casing ends to be joined by welding must be properly prepared, beveled and gapped to allow full penetration of the weld. All stick welded joints must have a minimum of two (2) passes including a "root" pass and have minimal undercut when complete. (5-8-09)
- i. In addition to meeting these standards, all wells that are constructed for public water systems must meet all of the casing wall thickness requirements set forth by the Idaho Department of Environmental Quality Rules, IDAPA 58.01.08, "Idaho Rules for Public Drinking Water Systems." (5-8-09)
- ii. The well driller must install steel casing that meets or exceeds the American Society of Testing and Materials (ASTM) standard A53, Grade B or American Petroleum Institute (API) 5L Grade B, and that meets the following specifications for wall thickness:

Minimum Single-Wall Steel Well Casing Thickness1 for Selected Diameters (inches)													
Nominal Diameter (in.) ³	6 ²	8	10	12	14	16	18	20	22	24	26	28	30
Depth (ft.)	Nominal Wall Thickness (in.) ¹												
<100	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250
100-200	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250
200-300	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250
300-400	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.375	0.375	0.375	0.375
400-600	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.375	0.375	0.375	0.375	0.375
600-800	0.250	0.250	0.250	0.250	0.250	0.250	0.375	0.375	0.375	0.375	0.375	0.375	0.375
800-1000	0.250	0.250	0.250	0.250	0.375	0.375	0.375	0.375	0.375	0.375	0.375	0.375	0.375
1000-1500	0.280	0.322	0.365	0.375	0.375	0.375	0.375	0.375	0.375	0.375	0.375	0.375	0.375
1500-2000	0.280	0.322	0.365	0.375	0.375	0.375	0.375	0.375	0.375	0.375	0.375	0.375	0.375

¹ Compliance with the minimum nominal wall thicknesses listed is required for any depth or location where casing is used to prevent caving or collapse, or both, of the borehole or serves as a solid inner barrier to allow for the installation of an annular seal.

- **b.** Thermoplastic Casing. Thermoplastic casing may be used in monitoring wells and cold water wells if drilling of the borehole confirms its suitability for use. (5-8-09)
- i. Thermoplastic casing must conform to ASTM F 480 and NSF-WC. The well driller must not use thermoplastic casing under any condition where the manufacturer's resistance to hydraulic collapse pressure (RHCP) or total depth specifications are exceeded. Thermoplastic casing extending above-ground must be protected from physical and ultraviolet light damage by enclosing it within steel casing extending at least twelve (12) inches above land surface and finished grade and to a minimum depth of eighteen (18) feet below land surface or five (5) feet

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² For nominal casing diameters less than six (6) inches, the minimum nominal wall thickness must be equivalent to ASTM Schedule 40.

³ For any other casing diameter not addressed herein, prior approval by the Director is required.

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below land surface for monitoring wells.

(5-8-09)

- ii. Thermoplastic pipe used in wells as casing or liner must have a minimum rating of SDR-21. For nominal diameters of four (4) inches or less, a minimum rating of Schedule 40 is required. If used as casing within unconsolidated or unstable consolidated formations, thermoplastic pipe must be centralized and fully supported throughout the unstable zone(s) with filter pack or seal material as required by these rules. (5-8-09)
- iii. All thermoplastic casing and liner must be installed in accordance with the manufacturer's recommendations and specifications, and as required by these rules. The well driller will not treat thermoplastic pipe in any manner that would adversely affect its structural integrity. The well driller must: (5-8-09)
- (1) Ensure that the weight of the pump assembly, if secured to the thermoplastic pipe, does not exceed the weight limitations per manufacturer's recommendations or cause damage to the pipe resulting in breaks or leaks.

 (5-8-09)
- (2) Not use Type III (high-early strength) Portland cement-based seal materials in direct contact with thermoplastic pipe unless approved by the Director. (5-8-09)
- (3) Not drive, drop, force, or jack thermoplastic pipe into place. Thermoplastic pipe must be lowered or floated into an oversized, obstruction-free borehole. (5-8-09)
- **c.** Perforated Well Casing. Perforated well casing may be used in the construction or decommissioning of a well when such application does not violate any standards required by these rules. (5-8-09)
- **05 Liner.** In addition to well casing, liners may be installed in wells to prevent damage to pumping equipment. Steel or thermoplastic pipe may be installed as liner in a well with a bottom hole temperature of eighty-five (85) degrees Fahrenheit or less. Thermoplastic liner must conform to ASTM F 480 and NSF-WC. Thermoplastic liners must not be used in unconsolidated formations or unstable units. (5-8-09)
- **96.** Screen. Well screens must be used in constructing a well when necessary to avoid sand production (see sand production, Rule 25, Subsection 025.24). Well screens must be commercially manufactured, be slotted, louvered or wire wrapped, and be installed according the manufacturers specifications. (5-8-09)
- **a.** Screens may require a filter pack consisting of sand or gravel to further reduce the quantity of sand produced from the well. (5-8-09)
- **b.** The well driller will not install well screens, perforated casing or filter pack across a confining layer(s) separating aquifers of different pressure, temperature, or quality. (5-8-09)
- **O7. Use of Approved Sealing Materials and Required Annular Space**. Well casings must be sealed in the required annular space with approved material to prevent the possible downward movement of contaminated surface waters or other fluids in any annular space around the well casing (Figure 02, Appendix A). Proper sealing is also required to prevent the movement of groundwater either upward or downward from zones of different pressure, temperature or quality within the well or outside the casing. The well driller must notify by phone the Department's appropriate Region Office at least four (4) hours in advance of placing any annular seal to provide Department staff the opportunity to observe seal placement. (5-8-09)
- a. All casing to be sealed must be adequately centralized to ensure uniform seal thickness around the well casing. Surface seals must extend to not less than thirty-eight (38) feet below land surface for well depths greater than thirty-eight (38) feet. For well depths less than thirty-eight (38) feet, seals must extend to depths as hereafter required. (5-8-09)
- **b.** Seals are required at depths greater than thirty-eight (38) feet in artesian wells or to seal through confining layers separating aquifers of differing pressure, temperature, or quality in any well. (5-8-09)
- **c.** When a well is modified and the existing casing is moved or the original seal is damaged, or a well driller discovers that a seal was not installed or has been damaged, the well driller must repair, replace, or install a

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seal around the permanent casing that is equal to or better than required when the well was originally constructed.

(5-8-09)

- d. Manufactured packers and shale traps may be used as devices to retain approved seal material when installing a required annular seal. Whenever these devices are used to retain seal material, the well driller must comply with the manufacturer's recommendations for installation. (5-8-09)
- **e.** If a temporary casing has been installed, upon completion of the drilling, the annular space must be filled with approved seal material and kept full while withdrawing the temporary casing. Bentonite chips should be used with caution when the annular space between a temporary casing and permanent casing is filled with water.

 (5-8-09)
- i. When attempts at removing a temporary casing are unsuccessful, the casing must be sealed in place by a method approved by the department. (5-8-09)
- ii. The well driller must notify the department whenever a temporary casing can not be removed and propose a plan to adequately seal the casing to prevent waste and contamination of the ground water. The plan must detail how the casing will be sealed on the outside to a sufficient depth below land surface in addition to placement of any required formation seals through the interval at which the casing will remain. (5-8-09)
- **f.** For mixed grout seals the minimum annular space required must provide for a uniform seal thickness not less than one (1) inch on all sides of the casing or a borehole at least two (2) inches larger than the outside diameter (OD) of the casing to be sealed (Figure 02, Appendix A). (Note: a seven and seven-eighths (7 7/8) inch diameter (eight (8) inch nominal) borehole around a six and five-eighths (6 5/8) inch OD (six (6) inch nominal casing does not satisfy the minimum annular space requirements). (5-8-09)
- i. When placing grout seals with a removable tremie pipe between casing strings or between a borehole and casing, the required annular space must be at least one (1) inch or equal to the OD of the tremie pipe whichever is greater. Permanent tremie pipes will be considered as a casing string and subject to minimum annular space requirements in addition to the annular space requirements around the well casing (Figure 03, Appendix A).

 (5-8-09)
- ii. All grout seals must be placed from the bottom up, by using an approved method. Bentonite grout must not be used above the water table unless specifically designed and manufactured for such use and approved by the Director in advance. (5-8-09)
- iii. If cement-based grout (neat cement or neat cement grout) is used to create a seal, the casing string sealed must not be moved or driven after the initial set. Construction must not resume for a minimum of twenty-four (24) hours following seal placement; (5-8-09)
- g. For dry bentonite seals the minimum annular space required must provide for a uniform seal thickness not less than one and five-eighths (1 5/8) inches on all sides of the casing or a borehole at least four (4) inches larger than the "nominal diameter" of the casing to be sealed. e.g., (six and five-eighths (6 5/8) inch OD (six (6) inch nominal) casing requires a ten and three fourths (10 3/4) inch OD (ten (10) inch nominal) temporary casing or a nine and seven-eighths (9 7/8) inch (ten (10) inch nominal) minimum borehole). Listed below are additional annular space requirements and limitations for placement of dry bentonite seals:

 (5-8-09)
- i. All dry bentonite seals must be tagged during placement and consider volumetric calculations to verify placement. (5-8-09)
- ii. Installation of dry bentonite seals must be consistent with the manufacturers' recommendations and specifications for application and placement. (5-8-09)
 - iii. Granular bentonite must not be placed through water. (5-8-09)
- iv. If a granular bentonite seal is placed deeper than two hundred (200) feet, the minimum annular space must be increased by at least one (1) inch e.g., (six and five-eighths (6 5/8) inch OD (six (6) inch nominal)

casing requires a twelve and three fourths (12 3/4) inch OD (twelve (12) inch nominal) temporary casing or an eleven and seven eights (11 7/8) inch (twelve (12) inch nominal) minimum borehole). (5-8-09)

- v. Bentonite chips may be placed through water or drilling fluid of appropriate viscosity. Bentonite chip seals placed through more than fifty (50) feet of water or drilling fluid will require the minimum annular space to be increased by at least one (1) inch e.g., (six and five-eighths (6 5/8) inch OD (six (6) inch nominal) casing requires a twelve and three fourths (12 3/4) inch OD (twelve (12) inch nominal) temporary casing or an eleven and seven eights (11 7/8) inch (twelve (12) inch nominal) minimum borehole). (5-8-09)
- **08. Sealing of Wells.** Sealing requirements described herein are minimum standards that apply to all wells. The Director may establish alternate minimum sealing requirements in specific areas when it can be determined through detailed studies of the local hydrogeology that a specific alternate minimum will provide protection of the ground water from waste and contamination. (5-8-09)
- a. Consolidated Formations. When a water well is drilled into and acquires water from an aquifer that consists of consolidated formations that are above the water table, casing must be installed so that it extends and is sealed to a depth not less than thirty-eight (38) feet (Figure 04, Appendix A). If the well depth is less than thirty-eight (38) feet from land surface, well casing must be installed and sealed five (5) feet into the consolidated formation or to a depth of eighteen (18) feet, whichever is greater. (5-8-09)
- b. Unconsolidated Formations without Confining Layers of Clay. When a water well is drilled into and acquires water from an unconfined aquifer that is overlain with unconsolidated formations, such as sand and gravel without confining layers of clay, well casing must extend to at least five (5) feet below the water table and be sealed to a depth not less than thirty-eight (38) feet (Figure 05, Appendix A). If the well depth is less than thirty-eight (38) feet well casing must extend to at least five (5) feet below the water table or eighteen (18) feet, whichever is greater, and be sealed to a depth of at least eighteen (18) feet. (5-8-09)
- i. The extensive (for example, one hundred fifty (150) feet thick or more) unconsolidated, non-stratified, sand and gravel of the Rathdrum Prairie are characterized by extremely high transmissivity and hydraulic conductivity. Under these conditions, sealing wells to depths greater than eighteen (18) feet may not be additionally protective. When a water well is drilled within the boundaries of the Rathdrum Prairie, (shown in Figure 06, Appendix A of these rules), well casing must extend to at least five (5) feet below the water table and be sealed to a depth not less than eighteen (18) feet (Figure 07, Appendix A). (5-8-09)
- c. Unconsolidated Formations with Confining Layers of Clay. When a well is drilled into and acquires water from an aquifer that is overlain by unconsolidated deposits such as sand and gravel, and there are confining layers of clay above the water table, well casing must be installed from the land surface to the confining layer immediately above and in contact with the production zone and sealed to a depth not less than thirty-eight (38) feet (Figure 08, Appendix A). If the well depth is less than thirty-eight (38) feet from land surface, well casing must extend and be sealed into the first confining layer or to a depth of eighteen (18) feet, whichever is greater.

(5-8-09)

09. Sealing Artesian Wells.

(5-8-09)

a. Unconsolidated Formations. When artesian water is encountered in unconsolidated formations, the production zone or open interval must be limited to zones of like pressure, temperature, and quality. Water encountered in oxidized sediments must not be comingled with water encountered in reduced sediments. Well casing must extend from land surface into the lower most confining layer above the production zone, and must be sealed:

(5-8-09)

- i. From land surface to a depth of at least thirty-eight (38) feet; and
- (5-8-09)

ii, Through all confining layer(s); and

(5-8-09)

(1) A minimum of five (5) feet of seal material must be placed into or through the lower most confining layer above the production zone (Figure 09, Appendix A); or (5-8-09)

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- (2) Five (5) feet into or through the lowermost confining layer above the production zone and continuously to land surface (Figure 09, Appendix A). (5-8-09)
- iii. If the well depth is less than thirty-eight (38) feet, the well must be cased and sealed from land surface to the confining layer in direct contact with the production zone or to a depth of eighteen (18) feet, whichever is greater.

 (5-8-09)
- **b.** Consolidated Formations. When artesian water is encountered in a consolidated formation, well casing must be installed and sealed from land surface to a depth of at least thirty-eight (38) feet; and (5-8-09)
- i. If the consolidated formation is overlain by a permeable formation(s) and water will rise above the consolidated formation, well casing must extend and be sealed at least five (5) feet into the confining portion of the consolidated formation (Figure 10, Appendix A). (5-8-09)
- ii. If the well depth is less than thirty-eight (38) feet, the well must be cased and sealed from land surface five (5) feet into the confining consolidated formation or to a depth of eighteen (18) feet, whichever is greater.

 (5-8-09)
- c. Control Device. Pursuant to Section 42-1603, Idaho Code, if the well flows at land surface, it must be equipped with a control device approved by the Director, so that the flow can be completely stopped. If leaks occur around the well casing or adjacent to the well, the well must be completed with seals, casing or cement grout to eliminate the leakage.

 (5-8-09)
- i. Flowing artesian wells must be equipped with an approved pressure gage fitting that will allow access for measurement of shut-in pressure of a flowing well. All pressure gage fittings must include control valves such that the pressure gage can be removed without resulting in artesian flow from the well. (5-8-09)
- ii. The well driller must not move his well drilling rig from the site until all requirements have been satisfied. Some mixing of water may be allowed to develop an adequate water well; however, the mixing must be restricted to water zones of similar pressure, temperature and quality. The driller must take precautions to case and seal out zones which may lead to waste or contamination. (5-8-09)
- 10. Alternative Methods for Sealing Wells. To accommodate for new technology, and in consideration of the wide variety of drilling equipment used to construct wells, other methods of sealing wells not specifically addressed in these rules may be allowed. The Director may consider specific proposals for alternative methods of sealing on a case by case basis. Director approval or acceptance of such procedures will not constitute a "waiver" of any requirements of these rules. In such cases, the well driller must provide sufficient information for the Director to determine that the full intent of the sealing requirements will be satisfied if an alternative method is employed. If it is determined that a specific alternate method will provide protection of the ground water from waste and contamination, the Director may issue a statement of acceptance qualifying the use and implementation of such methods.

 (5-8-09)
- 11. Injection Wells. In addition to meeting the requirements of Rule 25 of these rules, the construction, modification, or decommissioning (abandonment) of all injection wells over eighteen (18) feet in vertical depth must also comply with the IDAPA 37.03.03, "Rules for the Construction and Use of Injection Wells," and the injection well permit. Drillers must obtain from the Director a certified copy of the permit authorizing construction or modification of an injection well before beginning work.

 (5-8-09)
- 12. Cathodic Protection Wells. All cathodic protection wells must be constructed by a licensed well driller in compliance with these rules. A detailed construction plan must be included with the drilling permit application. (5-8-09)
- 13. Monitoring and Remediation Wells. All monitoring wells and remediation wells must be constructed and maintained in a manner that will prevent waste or contamination and as otherwise required by these rules. When a monitoring well or a remediation well is no longer useful or needed, the owner or operator of the well must decommission (abandon) the well in accordance with Rule 25, Subsection 025.16 of these rules. No person may divert ground water from a monitoring well or a remediation well for any purpose not authorized by the Director. The

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application for a permit for all monitoring wells and all remediation wells must include a design proposal prepared by a licensed engineer or registered geologist pursuant to Section 42-235, Idaho Code. Blanket permits for monitoring well and remediation well networks may be approved for site-specific monitoring and remediation programs. The designs and specification for monitoring wells and remediation wells must demonstrate that: (5-8-09)

- **a.** The ground water resources are protected against waste and contamination; (5-8-09)
- **b.** The well(s) will inject or withdraw only fluids, gasses or solutions approved by the Director; (5-8-09)
- **c.** The well(s) will be constructed so as to prevent aquifer commingling; and (5-8-09)
- **d.** The well(s) will be properly decommissioned (abandoned) upon project completion and in accordance with these rules. (5-8-09)
- 14. Closed Loop Heat Exchange Wells. The well driller must construct closed loop heat exchange wells consistent with these rules. The well driller is not required to install steel casing in such wells. When constructing a closed loop heat exchange well, the well driller must:

 (5-8-09)
 - **a.** Construct each borehole of sufficient size to provide the annular space required by these rules. (5-8-09)
 - **b.** Seal the annular space of each borehole with approved seal material in accordance with these rules; (5-8-09)
- **c.** Install fluid-tight circulating pipe, composed of high-density polyethylene, grade PE3408, minimum cell classifications PE355434C or PE345434C conforming to ASTM Standard D3350, or other Directorapproved pipe; (5-8-09)
- **d.** Join pipe using thermal fusion techniques according to ASTM Standards D-3261 or D-2683. All personnel creating such system joints must be trained in the appropriate thermal fusion technologies; (5-8-09)
 - **e.** Use only propylene glycol, or other circulating fluid approved by the Director; (5-8-09)
 - **f.** Ensure that any other system additive is NSF approved and has prior approval from the Director; (5-8-09)
 - g. Pressure test each loop with potable water prior to grout installation; (5-8-09)
- **h.** Pressure test the system with potable water prior to installation of the circulating fluid at one hundred percent (100%) of the designed system operating pressure for a minimum duration of twenty-four (24) hours; and (5-8-09)
- i. Properly repair or decommission (abandon) all loops failing the test by pressure pumping approved seal material through the entire length of each failed loop. After grouting, loop ends must be fused together or capped.

 (5-8-09)
- 15. Access Port or Pressure Gage. Upon completion of a well and before removal of the well rig from the site, the well must be equipped with an access port that will allow for measurement of the depth to water or an approved pressure gage fitting that will allow access for measurement of shut-in pressure of an artesian flowing well. All pressure gage fittings must include control valves such that the pressure gage can be removed. Approved access ports are illustrated in Figure 11, APPENDIX A, together with approved locations for pressure gage fittings. Air lines are not a satisfactory substitution for an access port. Nonflowing domestic and stock water wells that are to be equipped with a sanitary seal with a built-in access port are exempt from this requirement. (5-8-09)
 - 16. Decommissioning (Abandoning) of Wells. (5-8-09)

- a. The well owner is charged with maintaining and properly decommissioning (abandoning) a well in a manner that will prevent waste or contamination, or both, of the ground water. No person is allowed to decommission a well in Idaho without first obtaining a driller's license or receiving a waiver of the license requirement from the Director of the Department of Water Resources. Authorization is required from the Director prior to decommissioning any well. Upon decommissioning, the person who decommissioned the well must submit to the Director a report describing the procedure. (5-8-09)
- **b.** The Director may require decommissioning of a well in compliance with the provisions of these rules, if the well: (5-8-09)
 - i. Does not meet minimum well construction standards; (5-8-09)
 - ii. Meets the definition of an unusable well; (5-8-09)
 - iii. Poses a threat to human health and safety; (5-8-09)
 - iv. Is in violation of IDAPA 58.01.11, "Ground Water Quality Rule"; or (5-8-09)
 - v. Has no valid water right or other authorization acceptable to the Director for use of the well.

 (5-8-09)
 - **c.** When required by the Director, decommissioning must be done in accordance with the following: (5-8-09)
- i. Cased wells and boreholes without a continuous seal from the top of the intakes or screen to the surface. The well driller must use one (1) of the following methods as applicable: (5-8-09)
- (1) The Director may require that well casing be perforated every five (5) feet from the bottom of the casing to within five (5) feet of the surface. Perforations made must be adequate to allow the free flow of seal material into any voids outside the well casing. There must be at least four equally spaced perforations per section circumference. Approved grout must be pressure pumped to fill any voids outside of the casing. A sufficient volume must be used to completely fill the well and annular space; or (5-8-09)
 - (2) Fill the borehole with approved seal material as the casing is being removed. (5-8-09)
- ii. Cased wells and boreholes with full-depth seals. If the well is cased and sealed from the top of the screen or production zone to the land surface, the well must be completely filled with approved seal material.

 (5-8-09)
 - iii. Uncased wells must be completely filled with approved seal material. (5-8-09)
- iv. Dry hole wells or wells from which the quantity of water to meet a beneficial use cannot be obtained must be decommissioned with cement grout, concrete or other approved seal material in accordance with these rules.

 (5-8-09)
- 17. Completion of a Well. The Director will consider that every well is completed when the well drilling equipment has been removed, unless written notice has been given to the Director by the well driller that he intends to return and do additional work on the well within a specified period of time. Upon completion of the well, the well must meet all of the required standards. (5-8-09)
- **a.** Upon completion of drilling and prior to removal of well drilling equipment from a water well site, the top of the casing must be completely covered with: (5-8-09)
- i. A one-fourth inch (1/4") thick solid, new or like-new steel plate with a three-fourths inch (3/4) threaded and plugged access port, welded to and completely covering the casing (Figure 12, Appendix A); or (5-8-09)

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- ii. A threaded cap, or a commercially manufactured watertight sanitary well cap (Figure 12, Appendix A); or (5-8-09)
- iii. A commercially manufactured water-tight, snorkel-vented or non-vented well cap on any well susceptible to submergence; or (5-8-09)
- iv. A control device approved by the Director per Section 42-1603, Idaho Code, on any well that flows at land surface (Figure 11, Appendix A). (5-8-09)
- b. Upon the completion of every well, the well driller must permanently affix the stainless steel well tag to the steel surface casing in a manner and location that maintains tag legibility. For closed loop heat exchange wells, the well driller must obtain approval for the well tag placement and method of attachment. The well driller must secure each tag by:

 (5-8-09)
 - i. A full-length weld across the top and down each side of the tag; or (5-8-09)
 - ii. Using one (1) stainless steel, closed-end domed rivet near each of the four (4) corners of the tag. (5-8-09)
- iii. Prior to welding or riveting, the tag must be pre-shaped to fit the casing such that both sides to be welded or riveted touch the casing and no gaps exist between the tag and casing. (5-8-09)
- 18. Pitless Adapters. When a pitless adaptor is used (Figure 12, Appendix A), the adaptor should be of the type approved by the NSF International testing laboratory or the approval code adopted by the Pitless Adaptor Division of the Water Systems Council. The pitless adaptor, including the cap or cover, casing extension, and other attachments, must be so designed and constructed to be water tight and to prevent contamination of the potable water supply from external sources. If a permanent surface or outer casing is installed and is cut off or breached to install the pitless adapter on an inner well casing or liner, the space between the permanent outer casing and the liner or inner casing must be sealed. The well owner or person installing the pitless adaptor must then seal the excavation surrounding the pitless adaptor using an approved seal material. (5-8-09)
- **19. Pump Installation**. No person is allowed to install a pump into any well that would cause a violation of Rule 25, of these rules or other applicable rules or state law. (5-8-09)
- **20. Explosives**. Explosives used in well construction must never be detonated inside the required well casing. Approved explosive casing perforators may be exempted by the Director. (5-8-09)
- **21. Hydraulic Fracturing**. Hydraulic fracturing must be performed only by well drillers licensed in Idaho. The pressure must be transmitted through a drill string and must not be transmitted to the well casing. The driller must provide a report to the Director of the fracturing work which must include well location, fracturing depth, fracturing pressures and other data as requested by the Director. (5-8-09)
- **22. Drilling Fluids or Drilling Additives.** The well driller must use only potable water and drilling fluids or drilling additives that are manufactured for use in water wells, are NSF International, American Petroleum Institute (API), or ASTM/ANSI approved; and do not contain a concentration of any substance in excess of Primary Drinking Water Standards, as set forth in IDAPA 58.01.08, "Rules for Public Drinking Water Systems," according to manufacturer's specifications. The well driller may seek approval from the Director to use specific, non-certified products on a case-by-case basis. In addition, the well driller must ensure the containment of all drilling fluids and materials used or produced to the immediate drilling site, and will not dispose of such fluids or materials into any streams, canals, boreholes, wells, or other subsurface pathways. (5-8-09)
- **23. Disinfection and Decontamination**. Upon completion of a well, the driller is responsible for adding the appropriate amount of disinfecting chemical compound and distributing it throughout the well to achieve a uniform concentration for "in place" disinfection of the well. Chlorine compounds used in accordance with the table listed below will satisfy this requirement. Other methods may be used if approved by the Director in advance.

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Amount of Chlorine Needed Per 100 Feet of Water in Well						
Casing Diameter (in.)	Gallons of water in cas- ing per 100 ft. of water depth	Amount of 5.25% Sodium Hypochlorite (Unscented Laundry Bleach)	Amount of 65% Calcium Hypochlorite (Chlorine Granules)			
6	147	2 ¼ cups	3 tbsp			
8	261	4 cups	5 tbsp			
10	408	6 ¼ cups	½ cup			
12	588	9 cups	¾ cup			
16	1044	1 gal	1 ¼ cup			

Note: 1 gal = 4 qt = 8 pt = 16 cups; 1 cup = 16 tbsp

Chlorine granules or tablets must be dissolved and placed into the well as a solution.

If another concentration of hypochlorite solution is used, the following equation should be used for calculating amounts.

(Volume of water in gallons) X (0.08) / % Hypochlorite (e.g. 50% = 50) = cups of hypochlorite

Example: To treat 147 gallons of water using a 50% concentration of hypochlorite solution: $(147 \text{ gallons water}) \times (0.08) / 50 = .23$ (or approximately 1/4) cup of 50% Hypochlorite solution

(5-8-09)

- **24. Sand Production.** The maximum sand content produced from a well after initial well development must not exceed fifteen (15) ppm. For the purpose of this rule, sand is considered to be any sediment particle retained on a U.S. standard sieve #200 (seventy-five hundreths (0.075) mm to two (2) mm). (5-8-09)
 - **a.** When necessary to mitigate sand production the well driller must: (5-8-09)
 - i. Construct each well with properly sized casing, screen(s) or perforated intake(s); and (5-8-09)
 - ii. Install properly sized filter pack(s); or (5-8-09)
 - iii. Install pre-packed well screens; or (5-8-09)
 - iv. Employ other methods approved by the Director. (5-8-09)
- **b.** The Director may grant a waiver exempting a well producing water that exceeds the maximum sand content only if the well driller has met the requirements of Rule 25, Subsection 025.24.a. (5-8-09)
- **c.** Sand production in public water system wells. Wells used in connection with a public water system have more stringent requirements. See IDAPA 58.01.08, "Idaho Rules for Public Water Systems." (5-8-09)
- **25. Well Development and Testing**. For each well the well driller must measure and record the static (non-pumping) water level and the pumping water level, and the production rate. The production rate will be determined by a pump, bailer, air-lift, or other industry approved test of sufficient duration to establish production from the well. For wells with no returns the driller must report no returns and the static water level. This information must be documented on the well driller's report. (5-8-09)

026. -- 029. (RESERVED).

030. CONSTRUCTION OF LOW TEMPERATURE GEOTHERMAL RESOURCE WELLS AND BONDING (RULE 30).

- **01. General.** Drillers constructing low temperature geothermal resource wells (bottom hole temperature more than eighty-five (85) degrees Fahrenheit and less than two hundred twelve (212) degrees Fahrenheit) must be qualified under the Well Driller Licensing Rules. All low temperature geothermal resource wells must be constructed in such a manner that the resource will be protected from waste due to lost artesian pressure and temperature. The owner or well driller is required to provide bottom hole temperature data, but the Director may make the final determination of bottom hole temperature, based upon information available to him. (5-8-09)
- **a.** All standards and guidelines for construction and decommissioning (abandonment) of cold water wells apply to low temperature geothermal resource wells except as modified by Rule 30, Subsections 030.03, 030.04, and 030.06. (5-8-09)
- **b.** A drilling prospectus must be submitted to and approved by the Director prior to the construction, modification, deepening or decommissioning (abandonment) of any low temperature geothermal resource well. The well owner and the well driller are responsible for the prospectus and subsequent well construction. (5-8-09)
- **Well Owner Bonding.** The owner of any low temperature geothermal resource well must file a surety bond or cash bond as required by Section 42-233, Idaho Code, with the Director in an amount not less than five thousand dollars (\$5,000) nor more than twenty thousand dollars (\$20,000) payable to the Director prior to constructing, modifying or deepening the well after July 1, 1987. The bond amount will be determined by the Director within the following guidelines. The bond will be kept in force for one (1) year following completion of the well or until released in writing by the Director, whichever occurs first. (5-8-09)
- a. Any well less than three-hundred (300) feet deep with a bottom hole temperature of less than one hundred twenty (120) degrees Fahrenheit and a shut-in pressure of less than ten (10) pounds per square inch gage (psig) at land surface must maintain a bond of five thousand dollars (\$5,000). (5-8-09)
- **b.** The owner of any well three hundred (300) feet to one thousand (1,000) feet deep with a bottom hole temperature of less than one hundred fifty (150) degrees Fahrenheit and a shut-in pressure of less than fifty (50) psig at land surface must maintain a bond of ten thousand dollars (\$10,000). (5-8-09)
- **c.** The owner of any low temperature geothermal resource well not covered by Rule 30, Subsections 030.02.a. and 030.02.b. must maintain a bond of twenty thousand dollars (\$20,000). (5-8-09)
- **d.** The Director may decrease or increase the bonds required if it is shown to his satisfaction that well construction or other conditions merit an increase or decrease. (7-1-93)
- e. The bond requirements of Section 42-233, Idaho Code, are applicable to wells authorized by water right permits or licenses having a priority date earlier than July 1, 1987, if the well authorized by the permit or license was not constructed prior to July 1, 1987 or if an existing well constructed within the terms of the permit or license is modified, deepened or enlarged on or after July 1, 1987. (7-1-93)
- **03. Casing.** Low temperature geothermal resource wells must be properly cased and sealed to protectfrom cooling by preventing intermingling with cold water aquifers. (5-8-09)
- **a.** Steel casing which meets or exceeds the minimum specifications for permanent steel casing of Rule 25, Subsection 025.04 must be installed in every well. The Director may require a more rigid standard for collapse and burst strength as depths or pressures may dictate. Every low temperature geothermal resource well which flows at land surface must have a minimum of forty (40) feet of conductor pipe set and cemented its entire length. (5-8-09)
- **b.** Casing must be installed from twelve (12) inches above land surface into the overlying confining strata of the thermal aquifer. The casing schedule may consist of several different casing strings (i.e. conductor pipe, surface casing, intermediate casing, production casing) which may all extend to land surface or may be overlapped and sealed or packed to prevent fluid migration out of the casing at any depth (Figure 13, Appendix A). (5-8-09)

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- i. Low temperature geothermal resource wells less than one thousand (1,000) feet deep and which encounter a shut-in pressure of less than fifty (50) psig at land surface must have two (2) strings of casing set and cemented to land surface. Conductor pipe must be a minimum of forty (40) feet in length or ten percent (10%) of the total depth of the well whichever is greater. Surface casing must extend into the confining stratum overlying the aquifer. (5-8-09)
- ii. Low temperature geothermal resource wells one thousand (1,000) feet or more in depth or which will likely encounter a shut-in pressure of fifty (50) psig or more at land surface require prior approval of the drilling plan by the Director and must have three strings of casing cemented their total length to land surface. Conductor pipe must be a minimum length of forty (40) feet. Surface casing must be a minimum of two hundred (200) feet in length or ten percent (10%) of the total depth of the well, whichever is greater. Intermediate casing must extend into the confining stratum overlying the aquifer. (5-8-09)
- c. Subsection 030.03.b. may be waived if it can be demonstrated to the Director through the lithology, electrical logs, geophysical logs, injectivity tests or other data that formations encountered below the last casing string set, will neither accept nor yield fluids at anticipated pressure to the borehole. (5-8-09)
- **d.** A nominal borehole size of two (2) inches in diameter larger than the Outside Diameter (O.D.) of the casing or casing coupler (whichever is larger) must be drilled. All casing designations must be by O.D. and wall thickness and must be shown to meet a given specification of the American Petroleum Institute, the American Society for Testing and Materials, the American Water Works Association or the American National Standards Institute. The last string of casing set during drilling operations must, at the Director's option, be flanged and capable of mounting a valve or blow out prevention equipment to control flows at the surface before drilling resumes. (5-8-09)
- **O4. Sealing of Casing.** All casing must be sealed its entire length with cement or a cement grout mixture unless waived by the Director. The seal material must be placed from the bottom of the casing to land surface either through the casing or tubing or by use of a tremie pipe. The cement or cement grout must be undisturbed for a minimum of twenty-four (24) hours or as needed to allow adequate curing. (5-8-09)
- **a.** A caliper log may be run for determining the volume of cement to be placed with an additional twenty-five (25%) percent on site ready for mixing. If a caliper log is not run, an additional one hundred (100%) percent of the calculated volume of cement must be on site ready for placement. (5-8-09)
- **b.** If there is no return of cement or cement grout at the surface after circulating all of the cement mixture on site, the Director will determine whether remedial work should be done to insure no migration of fluids around the well bore. (5-8-09)
- **c.** The use of additives such as bentonite, accelerators, retarders, and lost circulation material must follow manufacturer's specifications. (5-8-09)
- **05. Blow Out Prevention Equipment**. The Director may require the installation of gate valves or annular blow out prevention equipment to prevent the uncontrolled blow out of drilling mud and geothermal fluid.

 (7-1-93)
- **Repair of Wells**. The well driller must submit a drilling prospectus to the Director for review and approval prior to the repair or modification of a low temperature geothermal resource well. (5-8-09)
- **07. Decommissioning (Abandoning) of Wells**. Proper decommissioning (abandonment) of any low temperature geothermal resource well requires the following: (5-8-09)
 - **a.** All cement plugs must be pumped into the hole through drill pipe or tubing. (5-8-09)
 - **b.** All open annuli must be completely filled with cement. (5-8-09)
- **c.** A cement plug at least one hundred (100) feet in vertical depth must be placed straddling (fifty (50) feet above and fifty (50) feet below) the zone where the casing or well bore meets the upper boundary of each ground water aquifer. (5-8-09)

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- **d.** A minimum of one hundred (100) feet of cement must be placed straddling each drive shoe or guide shoe on all casing including the bottom of the conductor pipe. (5-8-09)
- **e.** A surface plug of either cement grout or concrete must be placed from at least fifty (50) feet below the top of the casing to the top of the casing. (5-8-09)
- **f.** A cement plug must extend at least fifty (50) feet above and fifty (50) feet below the top of any liner installed in the well. The Director may waive this rule upon a showing of good cause. (5-8-09)
- **g.** Other decommissioning (abandonment) procedures may be approved by the Director if the owner or operator can demonstrate that the low temperature geothermal resource, ground waters, and other natural resources will be protected. (5-8-09)
- **h.** Approval for decommissioning (abandonment) of any low temperature geothermal well must be in writing by the Director prior to the beginning of any decommissioning (abandonment) procedures. (5-8-09)

031. -- 034. (RESERVED).

035. HEALTH STANDARDS (RULE 35).

- **O1. Public Water System Wells.** In addition to meeting these standards, all wells that are constructed for public supply of domestic water must meet all of the requirements set forth by the Idaho Department of Environmental Quality Rules, IDAPA 58.01.08, "Idaho Rules for Public Drinking Water Systems." (5-8-09)
- **O2.** Special Standards for Construction of Wells When Mineralized or Contaminated Water Is Encountered. Any time in the construction of a well that mineralized or contaminated water is encountered, the well driller must take the appropriate steps necessary to prevent the poor quality waters from entering the well or moving up or down the annular space around the well casing. The method employed to case and seal out this water will be determined by the well driller, provided all other minimum standards are met. The well driller will take special precautions in the case of filter-packed wells to prevent water of inferior quality from moving vertically in the filter packed portions of the well. All actions taken will be clearly documented on the well driller's report. (5-8-09)
- **03. Distances From Contaminant Sources**. All water wells constructed for domestic use must comply with minimum distances from septic tanks, drain fields, drainfield replacement area and other siting requirements as set forth in Rule 25, Subsection 025.01.d. (5-8-09)

036. OWNERS RESPONSIBILITIES FOR WELL USE AND MAINTENANCE (RULE 36).

After a well is completed the well owner is responsible for water quality testing, properly maintaining the well, and reporting problems with a well to the Director. All wells must be capped, covered and sealed such that debris cannot enter the well, persons or animals cannot fall into the well, and water cannot enter the well around the outside of the casing. Pursuant to Section 42-1603, Idaho Code, the owner of any artesian well that will flow at land surface is required to apply to the Director for approval of a flow control device. (5-8-09)

01. Use. The well owner must not operate any well in a manner that causes waste or contamination of the ground water resource. Failure to operate, maintain, knowingly allow the construction of any well in a manner that violates these rules, or failure to repair or properly decommission (abandon) any well as herein required will subject the well owner to civil penalties as provided by statute. (5-8-09)

02. Maintenance. The well owner must:

(5-8-09)

- **a.** Not allow modification to wells under their control without first obtaining an approved Idaho Department of Water Resources (IDWR) permit, pursuant to Section 42-235, Idaho Code; (5-8-09)
 - **b.** Maintain the minimum casing height of twelve (12) inches above land surface and finished grade; (5-8-09)

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- c. Maintain the appropriate well cap, and control device if required, according to these Rules; and (5-8-09)
- **d.** Not install or allow the installation of any well pump that would cause a violation of the sand production requirements in accordance with these Rules or allow the well to pump in excess of that allowed by a valid water right or domestic exemption. (5-8-09)
- **e.** Maintain the well to prevent waste or contamination of ground waters through leaky casings, pipes, fittings, valves, pumps, seals or through leakage around the outside of the casings, whether the leakage is above or below the land surface. Any person owning or controlling a non-compliant well must have the well repaired by a licensed well driller under a permit issued by the Director in accordance with these Rules. (5-8-09)
- **New Construction**. The well owner must not construct or allow construction of any permanent building, except for buildings to house a well or plumbing apparatus, or both, closer than ten (10) feet from an existing well. (5-8-09)
- **04. Maintain All Other Separation Distances**. The well owner must not construct or install, or allow the construction or installation of any object listed in a location closer than that allowed by the table of Rule 25, Subsection 025.01.d. (5-8-09)
- **05.** Unusable Wells. The well owner must have any unusable well repaired or decommissioned (abandoned) by a licensed well driller under a permit issued by the Director in accordance with these Rules. S (5-8-09)
- Wells Posing a Threat to Human Health and Safety or Causing Contamination of the Ground Water Resource. The well owner must have any well shown to pose a threat to human health and safety or cause contamination of the ground water resource immediately repaired or decommissioned (abandoned) by a licensed well driller under a permit issued by the Director in accordance with these Rules. (5-8-09)

037. -- 039. (RESERVED).

040. AREAS OF DRILLING CONCERN (RULE 40).

01. General. (7-1-93)

- **a.** The Director may designate an "area of drilling concern" to protect public health, or to prevent waste and contamination of ground or surface water, or both, because of factors such as aquifer pressure, vertical depth to the aquifer, warm or hot ground water, or contaminated ground or surface waters. (7-1-93)
- **b.** The designation of an area of drilling concern does not supersede or preclude designation of part or all of an area as a Critical Ground Water Area (Section 42-233a, Idaho Code), Ground Water Management Area (Section 42-233b, Idaho Code), or Geothermal Resource Area (Sections 42-4002 and 42-4003, Idaho Code), (7-1-93)
- c. The designation of an area of drilling concern can include certain aquifers or portions thereof while excluding others. The area of drilling concern may include low temperature geothermal resources while not including the shallower cold ground water systems. (7-1-93)

02. Bond Requirement. (7-1-93)

- **a.** The minimum bond to be filed by the well driller with the Director for the construction or modification of any well in an area of drilling concern is ten thousand dollars (\$10,000) unless it can be shown to the satisfaction of the Director that a smaller bond is sufficient. (5-8-09)
- **b.** The Director may determine on a case-by-case basis if a larger bond is required based on the estimated cost to repair, complete or properly decommission (abandon) a well. (5-8-09)

03. Additional Requirements. (7-1-93)

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- **a.** A driller must demonstrate to the satisfaction of the Director that he has the experience and knowledge to adequately construct or decommission (abandon) a well which encounters warm water or pressurized aquifers. (5-8-09)
- **b.** A driller must demonstrate to the satisfaction of the Director that he has, or has immediate access to, specialized equipment or resources needed to adequately construct or decommission (abandon) a well. (5-8-09)

041. -- 044. (RESERVED).

045. DRILLING PERMIT REQUIREMENTS (RULE 45).

01. General Provisions. (7-1-93)

- **a.** Drilling permits are required pursuant to Section 42-235, Idaho Code, prior to construction or modification of any well. (5-8-09)
- **b.** Drilling permits will not be issued for construction of a well which requires another separate approval from the department, such as a water right permit, transfer, amendment or injection well permit, until the other separate permitting requirements have been satisfied. (5-8-09)
- **c.** The Director may allow the use of a start card permit or give verbal approval to a well driller for the construction of cold water single family domestic wells. Start cards must be received by the Department at least two office hours prior to commencing construction of the well. (5-8-09)
- **d.** The Director may give verbal approval to a well driller for the construction of a well for which other permitting requirements have been met, provided that the driller or owner has filed the drilling permit application and appropriate fee. (5-8-09)
- **e.** The Director will not give a verbal approval or allow the use of a start card permit for wells constructed in a designated Area of Drilling Concern, Critical Ground Water Area, or Ground Water Management Area. (5-8-09)
- **f.** A well driller will not construct, drill or modify any well until a drilling permit has been issued, or verbal approval granted. (5-8-09)

02. Effect of a Permit. (7-1-93)

- **a.** A drilling permit authorizes the construction or modification of a well in compliance with these rules and the conditions of approval on the permit. (5-8-09)
- **b.** A drilling permit does not constitute a water right, injection well permit or other authorization which may be required, authorizing use of water from a well or discharge of fluids into a well. (5-8-09)
 - **c.** A drilling permit may not be assigned from one owner to another or from one driller to another. (5-8-09)
- **d.** A drilling permit authorizes the construction of one (1) well, except for blanket monitoring well and blanket remediation well drilling permits. (5-8-09)
- **O3. Exclusions.**For the purposes of these Rules, artificial openings and excavations that do not constitute a well and are not subject to the drilling permit requirements must be modified, constructed, or decommissioned (abandoned) in accordance with minimum well construction standards. The Director may require decommissioning (abandonment) of artificial openings and excavations constructed pursuant to Rule 45, Subsection 045.03 of these rules, when the use ceases or if the holes may contribute to waste or contamination of the ground water. The following types of artificial openings and excavations are not considered wells: (5-8-09)

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IDAHO ADMINISTRATIVE CODE Department of Water Resources

IDAPA 37.03.09 Well Construction Standards Rules

- **a.** Artificial openings and excavations with total depth less than eighteen (18) feet. (5-8-09)
- **b.** Artificial openings and excavations for collecting soil or rock samples, determining geologic properties, or mineral exploration or extraction, including gravel pits. (5-8-09)
- **c.** Artificial openings and excavations for oil and gas exploration for which a permit has been issued pursuant to Section 47-320, Idaho Code. (5-8-09)
- **d.** Artificial openings and excavations constructed for de-watering building or dam foundation excavations. (5-8-09)
- **O4.** Converting an Artificial Openings or Excavations Not Constructed as a Well for Use as a Well. Artificial openings and excavations that were not constructed as a well pursuant to a drilling permit, if subsequently converted to obtain water, monitor water quantity or quality, or to dispose of water or other fluids, must be reconstructed by a licensed driller in compliance with well construction standards and drilling permit requirements. (5-8-09)

05. Fees. (7-1-93)

- **a.** Drilling permit fees are as prescribed by Section 42-235, Idaho Code.
- **b.** The difference between the drilling permit fee required by Section 42-235 Idaho Code as applicable, must be paid when an existing well constructed on or after July 1, 1987, for which the lower drilling permit fee was paid, is authorized by the Director for a use which would require the larger drilling permit fee.

(5-8-09)

(5-8-09)

046. -- 049. (RESERVED).

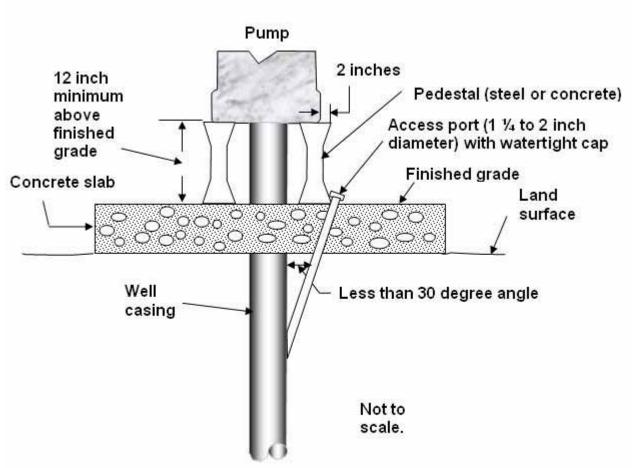
050. PENALTIES (RULE 50).

A person owning or controlling a well that allows waste or contamination of the state's ground water resources or causes a well not to meet the construction standards provided in these Rules is subject to the civil penalties as provided by statute. A driller who violates the foregoing provisions of these well construction standards Rules is subject to enforcement action and the penalties as provided by Statute. (5-8-09)

051. -- 999. (RESERVED).

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APPENDIX A Figure 01. Concrete Slabs and Finished Grade



Note. Pedestal shall not extend more than two (2) inches past pump base in horizontal direction.

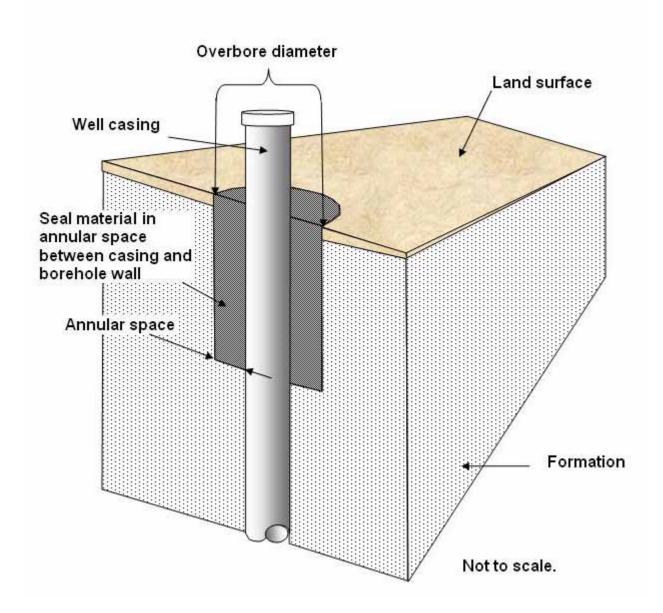
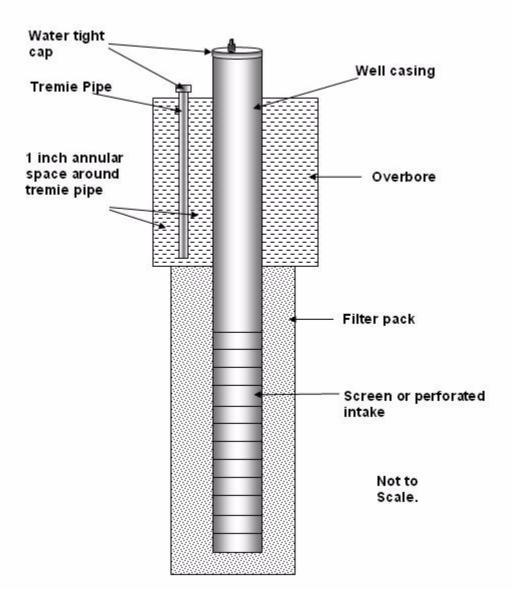


Figure 02. Annular Space and Overbore

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Figure 03. Overbore Requirements When a Tremie Pipe is Left in Place and A Grout Seal Installed



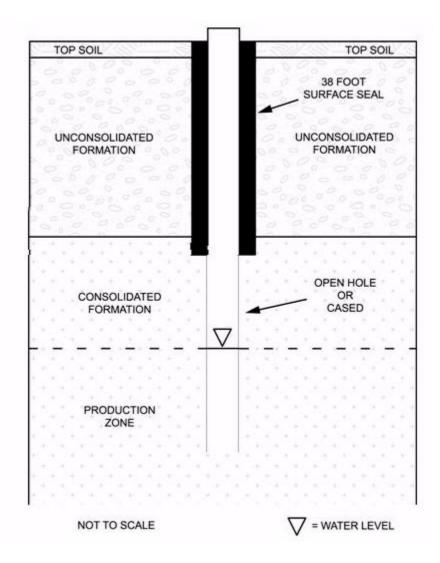
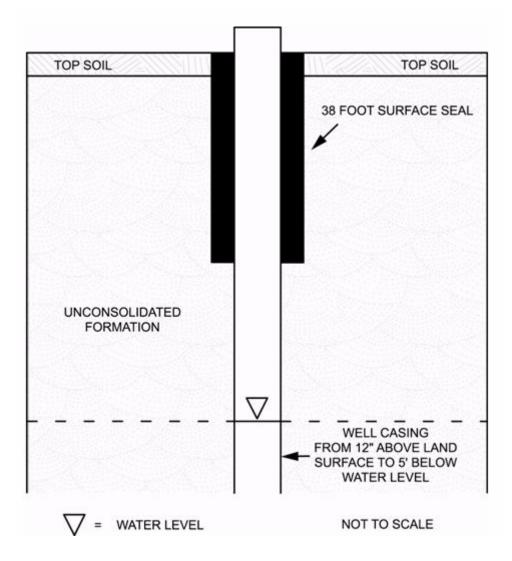


Figure 04. Sealing Requirements in Consolidated Formations

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Figure 05. Sealing Requirements in Unconsolidated Formation without Confining Layers



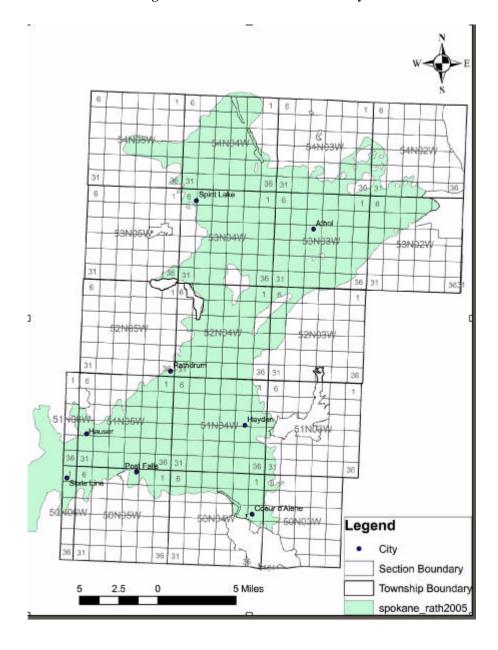


Figure 06. Rathdrum Prairie Boundary

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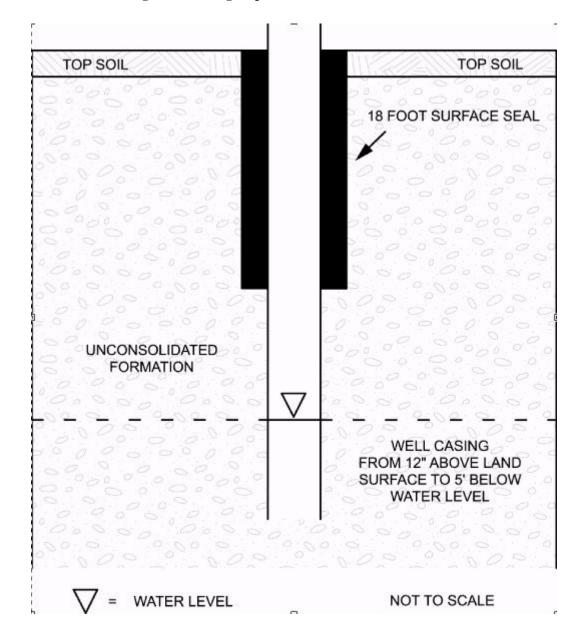


Figure 07. Sealing Requirements in the Rathdrum Prairie

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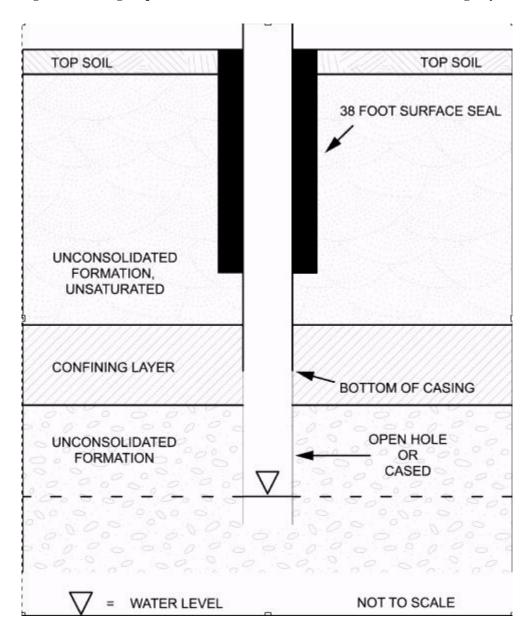


Figure 08. Sealing Requirements in Unconsolidated Formations with Confining Layers

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OPTION MEETING MINIMUM REQUIREMENTS OPTION WITH FULL LENGTH SEAL TOP SOIL TOP SOIL 38 FOOT SURFACE SEAL FULL LENGTH SEAL ∇ UNCONSOLIDATED FORMATION UNCONSOLIDATED FORMATION 5 FOOT SEAL CONFINING LAYER CONFINING LAYER ARTESIAN ZONE ARTESIAN ZONE PRODUCTION ZONE = WATER LEVEL NOT TO SCALE

Figure 09. Sealing Requirements for Artesian Wells in Unconsolidated Formations

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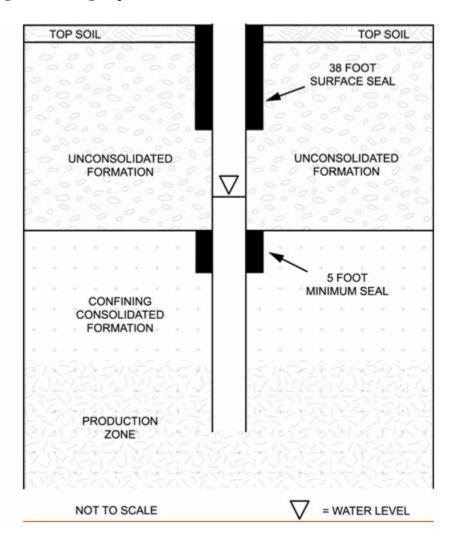
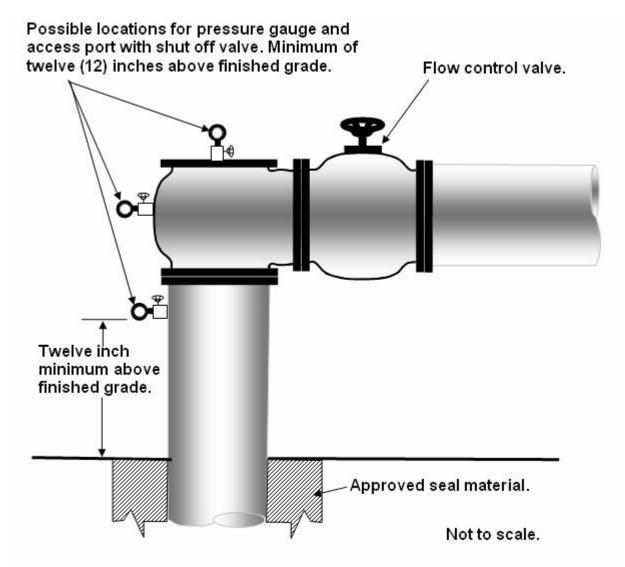


Figure 10. Sealing Requirements for Artesian Wells in Consolidated Formations

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Figure 11. Access Ports, Pressure Gauges, and Control Valves



Note. Application and approval of control device is required on any flowing artesian well per Section 42-1603, Idaho Code.

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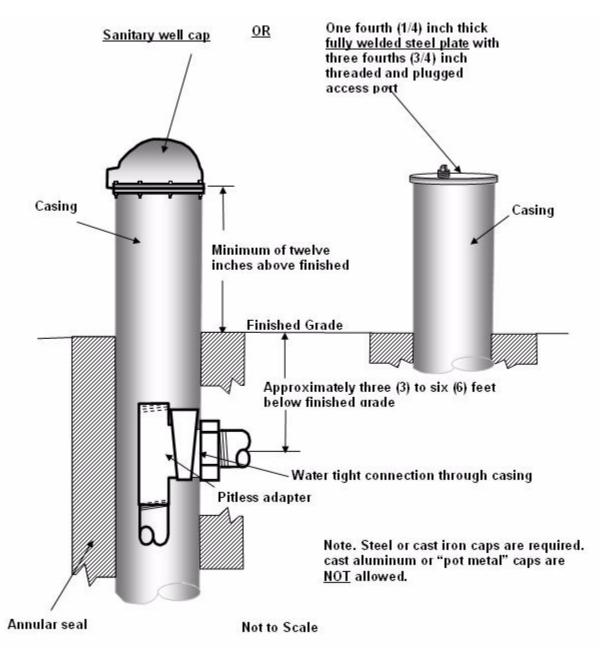


Figure 12. Well Cap and Access Port

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Approved control device per section 42-1603, Idaho Code Low temperature Cement Low temperature geothermal wells one Grout Seal geothermal wells less thousand (1,000) feet than one thousand deep or more require (<1,000) feet deep three strings of casing: require two strings of casing: 1) Conductor pipe; minimum forty feet. 1) Conductor pipe; -And; minimum forty feet or ten percent of total well 2) Minimum two depth, whichever is hundred (200) feet of greater. surface casing or ten percent of total well And: depth, whichever is 2) Surface casing to . greater. confining layer And; overlying the aquifer. Intermediate casing to confining layer overlying the aquifer. Confining layer Confining layer Production casing Not to scale.

Figure 13. Casing Requirements for Low Temperature Geothermal Wells

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APPENDIX B
TECHNICAL PROCEDURES

TECHNICAL GUIDELINE FOR MONITORING WELL DRILLING AND INSTALLATION TG-1.2-12

Rev. #8 8/20/2009



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August 2009
Revision Level 8
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1.0 PURPOSE

This document establishes uniform guidelines for the selection of materials and installation of monitoring wells or piezometers in unconsolidated and consolidated deposits.

2.0 APPLICABILITY

This technical guideline is applicable to all field personnel involved with the design and installation and abandonment of groundwater monitoring wells and piezometers. This document should be read in conjunction with any and all regulatory, workplan, order, client specific, or other project-specific guidelines.

3.0 DEFINITIONS

3.1. Monitoring Wells / Piezometers

A monitoring well is a well completed within a specific zone of interest, of sufficient diameter and construction to allow sampling and/or pump testing. A piezometer is typically a smaller diameter than a monitoring well, and is screened within a specific zone of interest, of sufficient diameter and construction to allow potentiometric measurements.

3.2. Bentonite

Bentonite is an expanding sodium bentonite clay used to seal the annular space between the production casing and the wall of the borehole. Calcium bentonite may be more appropriate in calcium-rich environments due to reduced cation exchange potential. Bentonite is also added to drilling circulation fluid on "mud" rotary rings to increase fluid viscosity and to transport drill cuttings to the surface more effectively. Additional information is provided in sections 7.2.6 through 7.2.10 and 7.2.13.

3.3. Casing, or "Drive" Casing

Drive casing is a pipe used to line a borehole to prohibit caving and/or prevent direct flow from the formation into the borehole. Hollow stem augers may be considered as analogous in function to drive casing for the purposes of this Technical Guideline.

3.4. Grout

Grout is a cement and/or bentonite mixture, originally fluid enough to be pumped through pipes, and used to seal casing within a borehole. Specifications are given in Section 7.2.6 and 7.2.7 below.

3.5. Well Screen

A well screen is a manufactured "wire"-wrapped, slotted or otherwise porous pipe which allows the flow of water from the formation into the well. Additional information is provided in section 7.2.1.

3.6. Monitoring Interval

The monitoring interval is the only zone in which groundwater can enter the well.





3.7. Centralizers

Centralizers are "basket-like" frames typically made of stainless steel that attach to the exterior of the casing, and whose radial metal bands keep the casing centralized in the borehole. Additional information is provided in section 7.2.2.

3.8. Riser Pipe

Riser pipe extends from the top of the screened interval to a short distance above ground surface (typically 2-3 feet).

3.9. Filter Pack/Sand Pack

Filter Pack/Sand Pack is material (typically granular) that is either placed on the exterior of the screen before installation, or pumped into the annulus between the screen and borehole wall after installation. Filter Pack/Sand Pack protects the screen, prevents clogging, and enhances flow into the well.

4.0 DISCUSSION

In order to generate quality data using these guidelines, it is incumbent on the field personnel to have reviewed these and other appropriate guidelines. This document should also be read in conjunction with any and all regulatory requirements, site-specific work plans, administrative orders, and client- specific or other project-specific procedures.

5.0 RESPONSIBILITIES

5.1. Field Supervisors

Field Supervisors are responsible for overseeing well installation in compliance with all project specific guidelines. The Field Supervisors are responsible for ensuring that the drilling contractors complete and submit all requirements (permit applications, well installation reports, etc.) before and after well installation. They must review and approve daily work reports and/or notes, and they must maintain daily borehole logs, well construction forms, etc.

5.2. Project Manager

The Project Manager shall be responsible for:

- Selecting location of the boreholes at the site and determining depth and the various design details of the monitoring well completion;
- Selection and contracting of services of drilling subcontractors;
- Scheduling;
- Assurance that appropriate equipment and materials are available to accomplish the task;
- Providing guidelines or specific work instructions for technical requirements beyond the scope of the applicable technical guidelines;
- The completion of drilling operations and well installations to the satisfaction of Golder's standards of operation and the clients' requirements; and
- Preparation of all reports and project deliverables.





5.3. Project Director/Principal-In-Charge

The Project Director shall be responsible for agreeing on design details outside the scope of this document and overall quality of project deliverables.

6.0 EQUIPMENT AND MATERIALS

6.1. Drilling Equipment

The following equipment may be used on most well drilling and installation jobs:

- A suitable drill rig (usually auger, cable tool, rotary, or direct push) with all equipment and accessories required for completing the job. The drill rig should be examined to determine the general condition, how well it has been maintained, and the general cleanliness of the drill rig and equipment. The drilling equipment should be relatively free of at least mineral oils, grease, hydraulic fluids, drilling mud, etc. Rig condition and corrective actions must be documented in the field log;
- A steam cleaner for cleaning drilling equipment between holes with associated wash rinse solutions (e.g., alkonox), storage tanks, brushes, and other equipment as necessary to capture and contain decontamination solutions:
- Additional equipment that may be required for drilling such as water trucks, drive casing, booster compressors, mud pumps, appropriate bits and sampling equipment (if required), additional support vehicles and equipment, etc.;
- Sampling equipment (core barrels, split-spoons, drive tubes, etc.) if needed; and
- A grout pump, mixer, and suitable clean tremie pipe, line, or pressure-grout system.

6.2. Field Engineering Equipment and Logs

The following equipment is suggested for documenting the construction of groundwater monitoring wells:

- Clipboard;
- Indelible ink pens and pencils;
- Engineering tape measure with 0.01 foot or, for some jobs, metric increments;
- Weighted engineering tape for sounding well material depth. The length of tape should be suitable for total anticipated well depth (check the accuracy of the weighted tape);
- Electric water level measuring tape suitable for total anticipated depth of borehole;
- Interface probe suitable for total anticipated depth of borehole;
- Color charts for soil comparison;
- 10% hydrochloric acid solution for calcareous deposits;
- Suitable containers for collecting samples of well construction materials;
- Sample containers for soil samples;
- Sample containers, cooler, etc. for chemical laboratory samples;





- Field Notebooks:
- History of Hole forms (Exhibit A);
- Borehole Log forms (Exhibit B);
- Monitoring Well Construction Forms (Exhibit C);
- Field Change Request (Exhibit D);
- Well development instrumentation, multi-parameter meter and calibration standards (meter should be capable of measuring pH, specific conductance, redox, dissolved oxygen and temperature);
- Turbidity meter and calibration standards; and
- Flow-through cell for collection of field measurements.

6.3. Health and Safety Equipment

All required equipment as shown by the Health and Safety Plan:

- Fire Extinguisher;
- First Aid Kit;
- Hard hat while drilling or near a drill rig- or pump truck;
- Steel-toed, and possibly steel-shanked, chemical resistant, or leather, or rubber boots;
- Suitable clothing that could include long sleeve shirts, long pants, etc.;
- Tyvek, other protective clothing, and respiratory protection devices as required by applicable site health and safety plans;
- Protective eyewear;
- Monitoring equipment as required by applicable health and safety plans; and
- Hearing protection while drilling or near a drill rig or pump truck.

7.0 PROCEDURE

7.1. Regulatory Considerations

In most states, both monitoring well and piezometer installation and their abandonment is specifically regulated by local, state, or regional regulations, laws and guidelines that pertain to the drilling, installation and abandonment of monitoring wells. In addition there may be client specific requirements. All such client and regulatory requirements must be reviewed before designing, drilling, and installing monitoring wells or piezometers. At a minimum, the following actions must be taken:

- Initiate start cards, permits, or other documents, certifications, and fees that may be required to drill and install monitoring wells or piezometers;
- Ensure that monitoring wells and piezometers will be drilled, installed and abandoned by an entity that meets all requirements (e.g., licenses) for conducting operations in that particular location;





- Initiate utility location process and document the location of all utilities before drilling, including both underground and overhead utilities. Check local codes for safety equipment (i.e., traffic codes, fire codes, etc.) required around drill rig during operation within city limits. Check that additional permits such as excavation or cultural reviews are not required, and be sure that overhead utilities will not interfere with the standing drilling rig; and
- Ensure that all follow up well or piezometer installation and abandonment reports required by appropriate agencies are completed by the drilling subcontractor and/or Golder and submitted. Obtain copies of all well and piezometer reports submitted by subcontractor for project files.

7.2. Materials

7.2.1. Well Screen

The well screen shall normally consist of machine slotted or "wire" wrapped, schedule 40 or 80 (ASTM-D1785) PVC pipe with flush joint threads. Both slotted and "wire" wrapped schedule 40 PVC are typically available at short notice. The use of other materials such as stainless steel or porous organic polymers may be required for certain situations where PVC may be reactive, may inhibit the collection of representative groundwater samples, may allow excess siltation, or may not be mechanically strong enough for a particular application. Use of alternative materials shall be specified by the Project Manager or by site-, regulatory-, or client- specific work documents.

Minimum requirements are identified below:

- A flush threaded bottom plug shall be installed securely in order to withstand all installation and development pressures without becoming damaged or dislodged, assuming (as is true in most cases) that the internal to be screened is at the bottom of the borehole.
- As a general rule, screen length should be the <u>minimum</u> necessary to achieve the objective for monitoring. The lengths of screens shall be determined by the Project Manager based on the site hydrogeology and other project-specific requirements. Screened interval, at or near the water table, will often be 5 to 20 feet in length (taking into account any annual fluctuations in the water table particularly if monitoring for light non-aqueous phase liquids). Wells completed at depth below the water table will usually be completed with a 3-, 5-, or 10-foot screen.
- All flush joint threads shall be sealed with any specified and supplied manufactured o-ring seals; Teflon tape shall be applied to the male threaded ends if the pipe is not equipped with o-rings. Riveted, screwed or glued joints shall not be permitted without agreement of the Project Director.
- The slot size will typically be 0.010 or in some cases 0.020-inches. The slot size shall be specified by the Project Manager and be determined relative to the formation particle size and the filter pack grain size. The use of a 0.006 or 0.008 slot size, or porous polymer screen should be considered in all cases where low turbidity is required and a properly designed sand-pack cannot be calculated for use with a 0.010 slot size.
- The screens shall typically have been factory cleaned to remove all oils, greases, solvents, waxes, etc. used in the manufacturing process and shall be individually wrapped and sealed or collectively stored and sealed in boxes from the factory.

7.2.2. Centralizers (Optional)

If required by the Project Manger or project work plans, friction or bolt-on style centralizers of appropriate material (typically stainless steel) shall be used. Deeper monitoring wells (i.e., >50' depth) will usually





benefit from centralizers if the well is installed in a borehole several times the diameter of the pipe and screen. Centralizers are typically not required for installing monitoring wells through auger flights.

7.2.3. Riser Pipe

The riser pipe shall typically consist of schedule 40 PVC or stainless steel with flush joint threads; the interval between joints shall be five to twenty feet. Minimum typical requirements are itemized below:

- A threaded cap or slip cap shall be provided for the top of the riser.
- All flush joint threads will be sealed with the supplied manufactured o-ring seals; Teflon tape shall be applied to the male threaded ends if the pipe is not equipped with o-rings.
- Riveted or glued joints shall not be permitted unless agreed by the Project Director.
- The riser pipe shall typically have been factory cleaned to remove all oils, greases, solvents, waxes, etc. used in the manufacturing process and shall be individually wrapped and sealed or collectively stored and sealed in boxes from the factory.

7.2.4. Steel Casing

In the event that a well requires permanent steel casing for hole stability or contamination seclusion, the following typical minimum requirements shall apply:

- The minimum inside diameter of steel casing shall be 4 inches in diameter larger than the nominal diameter of the well screen and riser (specific spacing requirements may be required by state regulations).
- The minimum wall thickness of steel casing shall be 0.125 inches; thicker casing may be required by state regulations or good engineering practice.
- The ends of sections of casing shall be threaded or beveled for welding or shall be designed to screw together.
- The casing should be in good condition and not out of round.
- The steel casing should be steam cleaned before use.

7.2.5. Filter Pack/Sand Pack

The filter pack/sand pack shall consist of dry, uniform, and well rounded grains of silica sand. The size of the sand grains will be selected by the Field Supervisor based on the water-bearing aquifer formation characteristics and the size of the screen slots. The sand shall be packaged in sacks typically with polyethylene liners and be clearly labeled as to manufacturer and mesh size of sand.

7.2.6. Cement/Bentonite Grout

Cement/Bentonite grout shall consist of a mixture of Portland Cement with 3-5% bentonite by weight added to help expand the cement on setting, thus providing a tighter seal. No other additives to the cement shall be permitted. Cement shall be Portland Cement Type I or Type II meeting ASTM C 150. The use of Hi Early Type III Cement is prohibited. Bentonite shall be powdered, typically sodium, bentonite furnished in sacks without additives; calcium bentonite may be used in certain calcium-rich environments. Water used during the installation operation for mixing cement/Bentonite grout shall be





obtained from a potable source or alternate source of known chemical quality designated by the Field Supervisor.

Cement shall be mixed with water in the proportions of five to six gallons of water per 94-lb sack of cement. Three to five pounds of bentonite powder shall be added to the mix for each sack of cement used. The grout shall be thoroughly mixed with a paddle type mechanical mixer or by circulating the mix through a pump until all lumps are removed. Grout which is lumpy shall be rejected.

7.2.7. Bentonite Grout

Bentonite grout shall be made from a bentonite powder and/or granules for use below the water table. The bentonite grout shall typically have a specific gravity of 2.5, a dry bulk density of 55 lb/ft³, and a pH of 9 to 10.5. Bentonite grout shall be mixed and used according to manufacturer's specifications and recommendations, and when mixed, will have a thick batter-like consistency. Bentonite shall be powdered or granular (8-20 mesh) sodium bentonite furnished in sacks without additives. Water used during installation operations for mixing bentonite grout shall be obtained from a potable source of known chemical quality identified by the Field Supervisor. The grout shall be thoroughly mixed with a paddle type mechanical mixed or by circulating the mix through a pump until all lumps are removed. Grout which is lumpy shall be rejected.

7.2.8. Volclay

Volclay is a trade name bentonite product that is modified with an initiator to increase the solids and set strength of the grout. The grout remains pumpable up to 2 hours but should be placed as soon after mixing is completed as possible. It sets up after 8-24 hours with final cure 24-72 hours after placement. The normal mix is 2.1 pounds of Volclay to 1 gallon of water. 14.3 pounds of Volclay mixed with 6.7 gallons of water yields 1 cubic foot of grout. A 50-pound bag of Volclay with the 2-pound bag of initiator mixed with about 24 gallons of water makes up about 3.5 cubic feet of grout. Because of potential desiccation and shrinkage, volclay shall only be used for sealing within water-saturated environments.

7.2.9. Pure Gold

Pure Gold is a trade name bentonite product that is an organic-free high-solids bentonite clay grout that has been tested and is certified to be free of contaminants. A 50-pound bag of Pure Gold grout is mixed with 14 gallons of water to yield approximately 2.2 cubic feet of grout. The grout should have density of 10.2 lbs/gal. Because of potential desiccation and shrinkage, pure gold shall only be used for sealing within water-saturated environments.

7.2.10. Bentonite Pellets/Chips

The two- to five- foot seal above the filter sand usually consists of bentonite pellets. Bentonite pellets will usually be a nominal 1/4- or 3/8-in. diameter round, or cylindrical pellets or chips consisting of untreated sodium bentonite, packaged in plastic buckets or plastic lined sacks. Each sack or bucket shall be clearly labeled as to the pellet size. The dry bulk density shall be at least 80 lbs/ft³. The diameter of the pellets or chips shall be less than one-half the width of the annular space into which they are to be placed. In some cases, and in particular when set in an unsaturated zone, the pellets/chips should be partly hydrated either before placement in the hole or periodically during placement.

7.2.11. Fine Sand Seals

Under certain circumstances when setting the seal in the unsaturated zone, the use of a fine sand seal may replace the bentonite pellet seal. The use of a fine sand seal must be approved by the Project





Manager. The sand used in these cases must be graded as fine (based on the Unified Soil Classification System), and must be a significantly finer grade of sand than used for the sand filter pack.

7.2.12. Concrete

Concrete, when used in monitoring well construction, shall be composed of either pre-mixed, bagged concrete, or a mix of six sacks of cement per cubic yard. Neither additives nor borehole cuttings shall be mixed with the concrete. The concrete pad is not usually steel reinforced. Concrete shall be mixed in accordance with manufacturer's specifications; water must be from an approved source with known chemical quality. The construction of the concrete monument pad/surface seal is shown on Figure 8-2.

7.2.13. Drilling Fluid

Drilling fluid circulates through the drill string, out the bit, and up the annulus to cool the bit and remove cuttings from the hole. Air is circulated on air-rotary rigs, while water or drilling "mud," usually comprised of a water/bentonite slurry, is used on mud rotary rigs. The viscosity of drilling fluid increases from air to water to "mud" as does its ability to transport cuttings to the surface. The viscosity of bentonite drilling "mud" is dependent upon the concentration of bentonite in the fluid, and is measured with a viscosity funnel.

7.3. Well Borehole Drilling

7.3.1. General Precautions

Water used for mixing cement or bentonite grout or used down hole during drilling should typically be chemically characterized, particularly for the analytes of interest at the site. The Project Manager or Task Leader must approve the water source before use. All bentonite and cement must be pure. Additives either contained in these materials or to be added to the mixture must be approved in writing by the Project Manager. All well screens and well casings should be factory cleaned and sealed or decontaminated prior to use. The seal must not be opened until use. The casing should not be allowed to touch the ground while installing. All down-hole drilling equipment must be decontaminated and cleaned prior to use on a borehole and before being demobilized from the site as noted in Section 7.3.4. below. The decontamination typically includes steam cleaning with a non-phosphate detergent (e.g., Alconox) followed by rinsing with water from an approved potable tap water source. The tap water rinse must be thorough to remove all detergent and grit. All wash solution will be captured and tested prior to disposal. The disposal of decontamination fluids shall be in accordance with the requirements of the appropriate state or federal agency.

7.3.2. Documentation

The Field Supervisor shall be responsible for ensuring that the drilling subcontractor completes and submits any required documentation before and following installation of the well or piezometer, required by regulators. All such records shall be reviewed and approved by the Golder Project Manager prior to submittal and copies of these documents shall be retained for the project files.

The Field supervisor(s) shall be responsible for maintaining a daily borehole log that shall be forwarded to the Task Leader on a daily basis. This log shall be a continuous, chronological log for each borehole/well/piezometer and should include, but not be limited to the following information: Date, well number, drillers name and company, depth and drilling characteristics of each stratigraphic unit drilled, the depth and thickness of each stratigraphic and water bearing zone encountered, any moist zones encountered, the time work starts and stops each day (and the hours spent at each task), time and durations of all shutdowns, depths of collected samples, method of drilling and any problems encountered, size of drill bit used, size, amount and type of any temporary or permanent casing used,





amount of water yielded or lost during drilling, type and amount of any drilling additives used, and the type and amount of any lubricants, if any, used on the drilling equipment and the types and quantities of any well construction materials used.

All significant drilling events during the installation of each monitoring well shall be documented daily on a form or in a bound field book. The documentation shall include the time that the events occurred; particular emphasis shall be placed on documenting the production hours and hours delayed in production, with appropriate explanations. Notes on the weather conditions and drilling personnel shall also be recorded. During completion, all backfilled materials and depths of well screens will be sounded with a measuring tape with attached weight on the sounding end. Well completion details shall be recorded on the Monitoring Well Installation Log (Exhibit C) by field staff. All information presented on the Monitoring Well Installation Log shall be recorded, or N/A for Not Available or Not Applicable entered as appropriate.

7.3.3. Initial Equipment Evaluation and Inspection

As soon as possible after the drill rig arrives on site, and certainly prior to beginning the drilling operation or decontamination of the drill rig, inspect and evaluate the drilling equipment supplied by the drilling subcontractor. The equipment should appear to be in good working condition, be maintained properly, and be the proper equipment specified for the job. Lifting cables, fittings, and ropes should be inspected for excessive wear or other signs of weakness. Field personnel should examine the rig for any oil or other fluid leaks that may be hard to detect after the drill rig has been decontaminated. If leaks are detected, discuss them with the subcontractor and arrange for them to be repaired or arrange for other means of containing the leaks around the well site. Inspect all equipment to be used by the subcontractor; this is the time to have arrangements made to get missing equipment to the site.

7.3.4. Decontamination of the Drill Rig and Drill Equipment

The drilling rig and all equipment in contact with soil materials or borehole fluids shall typically be steam cleaned (high pressure at 80 psi and high temperature at +180° F is acceptable) between each borehole. The subcontractor shall normally supply the equipment necessary for this decontamination. Fittings shall be carefully greased or lubed with vegetable oil and fluids carefully added to the drill rig <u>before</u> cleaning. Decontamination shall be conducted at an approved clean location outside the immediate drilling site. Any hazardous materials removed from the equipment must be contained to prevent the spread or release of such materials. Tools and sampling equipment (e.g., split spoon sampler, submersible pumps) to be used for soil sampling or aquifer testing shall generally be decontaminated by steam-cleaning. However, at the Project Manager or Task Leader's direction, the following additional decontamination method may be required: clean by wiping or scrubbing off visible particulate matter; wash with a laboratory-grade non-phosphate detergent (e.g., Alconox), rinse with clean water and isopropyl alcohol; and final rinse with HPLC-grade distilled/deionized water. The detergent, isopropyl alcohol (where necessary), and distilled water will usually be provided by Golder. All other decontamination equipment (e.g., brushes, clean water, buckets, steam cleaner) shall normally be provided by the subcontractor.

7.3.5. Setting up the Drill Rig

Drill rig set up shall be planned with the subcontractor. The prevalent wind direction should be accounted for if the rig will require a preferred orientation for extra cooling or to prevent exhaust from drifting over the decon or sample prep areas. The plan should account for the direction the dust or cuttings will be blown and the direction that will be downwind of the borehole if the borehole is likely to emit volatile organic vapors. The plan should account for the direction in which the water produced during the drilling operations will flow. The drill rig shall be set up by the subcontractor using levels to insure that the borehole is as plumb as possible. The verticality of the kelly or mast should be determined in two





directions: side to side and fore and aft. Ensure that the drill rig is adequately blocked below the jacks so that the rig is stable and minimum damage occurs to the land surface. Very fragile surfaces such as a sod yard should typically be protected using sheets of plywood to protect the land surface. Cut a hole in one sheet of plywood the size of the borehole for placing directly over the hole and place other sheets as needed around the site.

Confirm that the rig mast will be clear of all overhead power lines prior to hoisting the mast.

7.3.6. Borehole Size and Drilling Methods

The borehole size will be partly determined by the anticipated drilling requirements to reach the anticipated depth, e.g., will temporary casing need to be driven with the possibility of telescoping casing if refusal is encountered. The borehole size will also be determined by the completion size of the final well production casing/riser pipe and by the state or other regulatory requirements governing the size of the annular space around production and surface casing. The drill hole size and drilling methods will be determined by the Project Manager; methods may be selected from those provided in TG-1.4-5, "Drilling Sampling, and Logging of Soils", or TG-1.2-1, "Rock Core Drilling and Sampling".

7.3.7. Capture of Drill Cuttings and Groundwater

The soil or rock cuttings produced during the drilling operations and any groundwater produced by drilling below the water table may have to be captured if contaminants are anticipated or the site does not allow for the disposal of clean drill cuttings around the drill site. Unless otherwise directed by the Project Manager, the drill cuttings and groundwater should be captured in 55-gallon drums. The borehole number and depths of the cuttings contained in each drum should be noted in permanent paint on the side of the drum and on the lid. The soils and water can then be tested for the presence of the targeted contaminants. If the contaminants are detected, then the drummed cuttings and water must be disposed of in a proper manner as directed by state or other regulatory agencies. It is usually preferred to have the subcontractor move all the 55 gallon drums to a drum storage location that is secure and has been approved by the client/landowner.

Drill cuttings should be monitored continuously for changes in color, lithology, etc. Lothologic variations and the depths they occurred should be recorded on the Monitoring Well Installation Log (Exhibit C).

7.3.8. Verifying the Completed Borehole

Once the borehole has been completed, verify the final depth and determine how clean the borehole is by lowering and retrieving a weighted engineering tape to the total depth of the well. Lower a water level measuring probe down the borehole and record the water level in the borehole following completion of the borehole in compliance with procedure TG-1.4-6, "Water Level Measurement". If non-aqueous phase liquids are found or anticipated, an interface probe should be used to measure the thickness(es) of the non-aqueous liquids. If the borehole is to stand for any period of time before completion of the well, reprobe the borehole to determine the total depth and the water level within the borehole just prior to completion of the well. It is generally a poor practice to allow a borehole to stand open very long if there is the possibility of part of the borehole caving. At the Project Manager's direction, the stratigraphic sequence encountered in the borehole may be verified by geophysical logging. A variety of probes are available for stratigraphic, hydrogeologic and borehole geometry determinations. Geophysical logging equipment will require the same diligence in decontamination to prevent the potential introduction of contaminants into the borehole or well.





7.4. Well Installation

7.4.1. General Requirements

A properly completed well or piezometer should exhibit the following characteristics:

- The only portion of the completed well which will have well screen and a filter-pack/ sand pack should be adjacent to the particular water-bearing zone to be monitored.
- All other sections, except within 5 feet of land surface, should be sealed with a bentonite or cement/bentonite type grout. The liquid slurry grouts will be placed by pumping the grout through a tremie pipe to the appropriate locations, or, if bentonite pellets are used, the pellets will be properly rehydrated and compacted in place. Alternately in certain circumstances, a fine sand seal may be used in lieu of the bentonite seal.
- The uppermost 5 feet or more (or to below frost line) of the borehole annulus will typically be filled with a cement grout for a surface seal, stability in freezing weather, and for supporting protective surface monuments.

See Figure 8-1 for a typical well installation.

7.4.2. Evaluation of the Borehole

Compare the final completed borehole and the stratigraphic log of the samples or cuttings to the anticipated design for the monitoring well. Compare the strata to what was anticipated and verify that the depth is adequate. If the desired monitored interval is above the bottom of the borehole, the borehole must be backfilled with a low permeability grout. The grout shall be tremied slightly below the final depth of the well to the bottom of the borehole and the tremie pipe should be close to the bottom of the hole such that the grout is forced up from the bottom. The auger flights or steel casing shall be pulled or hammered out of the hole in five foot increments. This procedure should be repeated until the bottom of the drive casing or auger flights and top of the grout are equivalent to the bottom elevation of the desired monitoring interval.

The grout should be allowed to set prior to placing the gravel/sand pack and well casing/screen to establish a solid foundation. If bentonite grout does not harden adequately to permit a firm foundation for supporting the well, then a cement/bentonite grout should be used and allowed to harden. **Bentonite** and/or cement grout should never be allowed to harden while the drive casing is in contact. Care must be taken with cement and cement grouts. Cement can alter the pH of the groundwater that it comes in contact with. The best practice is to try and keep cement from being in direct contact with the sandpack of the monitored interval.

7.4.3. Assembly of Well Screen and Riser

The well screen including the bottom plug shall be clean and free of contamination immediately prior to assembly. Take precautions to ensure that grease, oil, or other contaminants do not contact the well screen. All workers handling the well screen shall wear a new pair of cotton or synthetic gloves. The male threaded part of each joint shall be wrapped with Teflon tape if not equipped with o-rings. Joints shall be tightened by hand; however, if necessary, clean pipe or chain wrenches may be utilized if care is exercised not to cut or damage the casing.

7.4.4. Setting the Well Screen and Riser String





The well screen shall be lowered to the predetermined level and held in position by suspending the string of riser pipe or if the string tends to float, by manipulating the hydraulic ram on the drill rig. On deep holes where the weight of the string riser pipe is significantly greater than the flotation force, care shall be taken to keep the riser pipe plumb. The riser shall typically extend above the ground at least three feet, and may be trimmed to the proper length after the grout is in place. If the plumbness of the riser is especially critical or the well is extremely deep, a probe or "dummy" should be lowered down the inside of the riser to verify that the riser is not kinked. The screen and riser string should be suspended from the surface as much as possible during completion, rather than sitting in the borehole, to avoid damaging the screen. At the Project Manager's direction or if required by project work plans, centralizers shall be placed typically at about 20-40 feet apart throughout the riser interval.

7.4.5. Placement of the Filter Pack

The volume of sand required to fill the annular space between the well screen and the wall of the borehole shall be computed by subtracting the volume of the well-screen from the borehole volume of the screened interval and then carefully measured to confirm. The sand pack shall typically extend three to five feet above the uppermost row of slots in the well screen except where limited separation between aquifers occurs (check state regulations). The well screen shall be centered in the well hole and temporary casing by suspending the well screen and riser string and/or using centralizers. At the Project Manager's direction or if required by project work plans, centralizers shall be placed typically at 20-40 feet apart through the screen interval.

While holding the riser pipe with the drill rig, the temporary casing or hollow stem augers shall be carefully withdrawn such that the lowermost point on the casing is exactly at the top of the sand packed portion of the well. This may be accomplished in increments; however, after each increment, a weighted engineering tape shall be inserted and lowered to ascertain that the sand pack has not been raised or lowered during casing withdrawal operation. If necessary the sand pack shall be tamped back into place.

7.4.6. Placement of the Bentonite Seal

A volume of pellets or chips to create a seal typically 3 to 5 feet long should be computed and measured out for introduction into the annular space. The bentonite pellets or chips may be placed by either tremieing the pellets to the required interval or hand pouring the pellets into the annular space at the top of the well. Tremieing of the pellets is usually done on deeper completions or if specifically required in the well completion specifications. Extreme care must be exercised and the pellets or chips slowly introduced into the annular space to prevent bridging above the level to be completed. In addition, the bottom of the casing must be maintained above the uppermost level of the pellets to avoid locking the well casing. If the bentonite seal is being constructed above the water level in the borehole, exactly five gallons of water per a 5-gallon bucket of pellets or bag of bentonite chips should be slowly poured into the annular space to rehydrate the bentonite. A weighted seal tamper should be lowered down the annulus and used to tamp the pellets or chips into a cohesive mass of clay.

7.4.7. Grouting the Annular Seal

A sample of the final grout shall be collected in a suitable container just prior to ordering the grout injection. The volume of grout, either bentonite or cement/bentonite, required to completely fill the annular space between the seal and the ground surface shall be prepared in the proportions specified in Section 7.2. The volume shall include a quantity to compensate for losses during injection and due to borehole irregularities. All hoses, tubes pipes, water swivels, drill rods, tremie pipes, or other passageways through which the grout will be pumped shall have an inside diameter of at least 0.5 inches.





The grout shall be injected via a side discharge tremie pipe with its opening temporarily set immediately above the bentonite seal. The grout shall be pumped into the tremie pipe continuously until it flows out of the annulus at the surface. Any temporary casing if used or auger flights shall be removed immediately and in advance of the time when the grout begins to set. Casing removal and injection may proceed concurrently provided the top of the column of grout is always at least twenty feet above the bottom of the casing and provided injection is not interrupted. If casing removal does not commence until grout injection is completed, then additional grout shall be periodically poured into the annular space so as to maintain a continuous column of grout up to the ground surface. Grout which has overflowed the well hole shall be carefully removed so as to prevent the formation of horizontal projections (mushrooming) which may be subject to frost heave. The well shall not be disturbed for 48 hours to permit the grout to gain sufficient strength.

7.4.8. Placement of Protective Well Monument, Concrete Pad/Seal

A well protector as shown in Figures 8-1 and 8-2 shall typically be constructed before the grout has set. The well protector shall be positioned and maintained in a plumb position with temporary braces as required. An eight inch clearance between the top of the riser and the well protector shall typically be maintained for the sampler. A 1/4 inch diameter hole shall usually be drilled in the well protector 6 inches above the ground surface to permit water to drain out of the annular space. Coarse sand and/or pea gravel shall be placed in the annular space at least 6 inches above the hole to prevent insects from entering through the drilled hole. A 4-inch thick concrete pad shall be constructed around the protective monument. The pad should be approximately 2 to 3 feet in radius and should slope slightly away from the monument on all sides. Three protective "bumper" posts may be installed evenly spaced around the well at a 3 to 5 foot radius. Each post should be flagged and/or painted for improved visibility. If the monument is to be painted, the monument shall be painted before placing it in the grout.

A permanent, weatherproof, well identifier shall be affixed to the outside of the protective well monument (check state regulations for monitoring well labeling requirements).

7.5. Well Development and Acceptance

This section covers the development of a newly constructed well and the measurement of the well characteristics.

7.5.1. Pumps and Accessories for Well Development

All wells shall be developed to produce representative formation water. This section describes the approved pumps and accessories to be used in development of monitoring wells. All pumps and other devices used in well development shall be clean and free of oil, grease, solvents, or any other contaminants.

7.5.1.1. Submersible Pumps

Submersible pumps shall include electric motor powered or pneumatic units. If a submersible pump is utilized for well development, it shall be of a type and capacity such that it can pump water from the well continuously for a period of at least five minutes without shutting off. Backpressure or other methods may be utilized to accomplish the desired rate of pumping. The pump shall be capable of being turned on and off instantaneously to create surging in the well. In almost all cases the pump shall <u>not</u> be fitted with a backflow check valve.





7.5.1.2. Bladder Pumps

A bladder or diaphragm pump shall operate by compressed air cycling to inflate and deflate a diaphragm which creates a pumping action. They should be of sufficient capacity to influence the monitored zone.

7.5.1.3. Jet Pumps

Jet pumps use the Venturi principle to create subatmospheric pressure to allow the pump to be used below a depth at which suction alone would not normally lift the water. Jet pumps approved for well development shall be capable of pumping at least 3 gpm continuously when installed in the well or piezometer.

7.5.1.4. Bailers

Bailers shall not be used for well or piezometer development except after an approved submersible bladder, jet or suction pump has been installed in the well or compressed air or bottled nitrogen has been used, and/or the rate of well recovery is so slow that these methods are ineffective. Small diameter wells may also require bailing for development due to the limited access of the casing diameter.

7.5.1.5. Compressed Air

Compressed air supplied by an engine-driven compressor equipped with an approved oil filter and trap may be used provided the source of compressed air is capable of evacuating 50 percent of the column of water from the well once every minute.

7.5.1.6. Bottled Nitrogen

Bottled nitrogen may be used provided a regulator is employed and the system is capable of evacuating 50 percent of the column water from the well once every minute.

7.5.2. Well Development

Well development should begin after the monitoring well is completely installed and prior to water sampling. Development should be continued until representative water, free of the drilling fluids, cuttings, or other materials introduced during well construction is obtained. Representative water is assumed to have been obtained when pH, temperature, and specific conductivity readings stabilize and the water is visually clear of suspended solids (verify whether or not local regulations have development criteria for turbidity measurements). The minimum duration of well development should vary in accordance with the method used to develop the well. For example, surging and pumping the well may provide a stable, sediment free sample in a matter of minutes; whereas, bailing the well may require several hours of continuous effort to obtain a clear sample. The duration of well development and the pH, temperature, and specific conductivity readings should be recorded in the daily log and on the Monitoring Well Installation Log (Exhibit C) by the Field Supervisor.

Purged groundwater shall be captured and contained in 55 gallon steel drums or suitable vessel(s), if a reasonable potential exists for the groundwater to contain hazardous substances as directed by the Project Manager or as specified in the project work documents.

If required, each drum or vessel containing captured purge water shall be properly labeled with a weather proof label as to the contents, the well(s) from which the contained purge water originated and the date on which the contents were generated. Storage of the containers shall be as specified in the project work documents or as directed by the Project Manager.





Captured and contained purge water shall be characterized for discharge, treatment and/or disposal. Characterization of the captured and contained purge water should be specified in the project work documents or by the Project Manager, but could rely on site knowledge, the analytical results of groundwater samples associated with each container, or could involve direct sampling and analyses of the contained water.

The requirements and options available for discharge, treatment and/or disposal are dependent upon many variables such as chemical consistency, local and state regulations and location of site. Discharge, treatment and/or disposal of captured and contained purge water must be in accordance with local, state and Federal regulations and shall be specified in the project work documents.

Water levels should be measured from ground surface or the concrete pad at the base of the well monument.

7.5.3. Well Recovery Test

A recovery test shall typically be performed immediately after development. Readings shall be taken at appropriate intervals (usually one minute or less) until the well has recovered to within 90% of its static water level. The extremely long recovery periods of some wells may prohibit carrying this test out to its completion; the decision to terminate shall be noted and justified on the Well Installation Log.

7.5.4. Well Acceptance

The final completed well shall be probed using a weighted engineering tape to determine that the well is unobstructed to total depth. A 10-foot rigid cylinder 1 standard size smaller than nominal well casing size can be lowered to the total depth of the well and retrieved to verify straightness of the well for tool access.

A well will be accepted by the Field Supervisor when development has been completed in accordance with these specifications, and the required drilling subcontractor's documentation has been furnished to Golder.

7.6. Site Cleanup

The Staging area, decontamination area, each well site and any other areas used during the well installation program shall be cleaned up by the subcontractor and inspected by the Field Supervisor. Unless agreed with the client, all trash should be removed; the 55-gallon drums of cuttings shall be organized into a temporary storage area and any concrete or asphalt that has been covered with mud shall be washed off. Cut or torn asphalt areas will be patched by the subcontractor using a cold patch material. Try to restore the area as much as possible to the condition before the well installation program.

7.7. Field Change Request

Variation from established procedure requirements may be necessary due to unique circumstances encountered on individual projects. All variations from established procedures shall be documented on a Field Change Request (Exhibit D) and reviewed by the Project Manager and the Project Director.

The Project Manager may authorize individual Field Supervisors to initiate necessary variations. If possible, the request for variation shall be reviewed by the Project Manager prior to implementation. If prior review is not possible, the variation may be implemented immediately at the direction of the Field Supervisor, provided that the Project Manager is notified of the variation within 24 hours of the implementation, and the Field Change Request is forwarded to the Project Manager within 2 working days of implementation. If the variation is unacceptable to either reviewer, the activity shall be





reperformed or action shall be taken as indicated in the Comments section of the reviewed Field Change Request. All completed Field Change Requests shall be maintained in project records.

7.8. Well Location

The level of accuracy required for horizontal well location and elevation shall be specified by the Project Manager or applicable project plans. At a minimum, well locations shall be approximated with tape and compass from known permanent landmarks. However, locations may be measured by alternate methods such as (1) triangulated with compass bearings; (2) by GPS if of sufficient accuracy; and (3) geodetic survey using standard survey techniques. Elevation of the riser casing shall be approximated. A licensed surveyor, if required, shall maintain 3rd order precision and accuracy. The surveyed point for the well riser shall be the highest point on the riser casing with the slip cap removed. That point shall be marked on the riser casing.

8.0 REFERENCED GUIDELINES

Golder Associates Inc. Technical Guideline TG-1.2-1, "Rock Core Drilling and Sampling."

Golder Associates Inc. Technical Guideline TG-1.2-5, "Drilling, Sampling, and Logging of Soils."

Golder Associates Inc. Technical Guideline TG-1.4-6, "Water Level Measurement."

9.0 ADDITIONAL REFERENCES, GUIDELINES AND PROCEDURES

ASTM D 1785 - Threaded, Flush Couplings on PVC Pipe.

Golder Associates Inc. Technical Guideline TG-1.2-20 "Collection of Groundwater Quality Samples" Golder Associates Inc. Quality Procedure QP-1, "Calibration and Maintenance of Measuring and Test Equipment."

Golder Associates Inc. Technical Guideline TG-1.2-23, "Chain of Custody."

Golder Associates Technical Guideline TG-2.3-3, "Headspace Analysis Using the Organic Vapor Analyzer"

Golder Associates Technical Guideline TG-1.1-2, "Geodetic Surveys."

Federal and/or State Regulations and Guidance

CFR 264/265 Subpart F

Resource Conservation and Recovery Act (RCRA) Ground-Water Monitoring

Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)

Applicable State Standard Operating Procedure





EXHIBIT A



Golder Associates HISTORY OF HOLE Sheet_____of___ Job No. _____ ______ Date______ Boring No______ ____Surface Elevation _____ Weather _____ Temp_ Geologist__ Contractor____ ____Drill Fluid_ Location_ BEGINNING OF SHIFT END OF SHIFT Time _____ Hrs Productive ____ Hrs. Deloyed ____ Time _____ Depth of Hole ____ Depth of Hole _____ Depth of Casing ____ Depth to WL_ Depth to WL _____ Depth of Casing __ Checked by:

HISTORY OF HOLE



EXHIBIT B



Golder Associates Field Boring Log

DEPTH HOLE	JOB NO.	PROJECT		BORING NO.
DEPTH SOIL DRILL	GA INSP.	DRILLING METHOD		SHEET OF
DEPTH ROCK CORE	WEATHER	DRILLING COMPANY		SURFACE ELEV.
NO. DIST. SA UD. SA	TEMP	DRILL RIG	DRILLER	DATUM
DEPTH WL.	HRS. PROD.	WT. SAMPLER HAMMER	DROP	STARTED/
TIME WL.	HRS. DELAYED	WT. CASING HAMMER	DROP	COMPLETED

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EXHIBIT C



MONITORING WELL INSTALLATION LOG

JOB NO.______ PROJECT______ SHEET _____ OF__

					ELEV WATER DEPTH
					ELEV DATE/TIME
TEMP	DRILL RIG	DRILLER		STARTED -	TIME / DATE COMPLETED TIME / DATE
		MATERIALS	INVENTOR	Υ	
WELL CASING	ia dio 12				BENTONITE SEAL
	in. diai.t.				INSTALLATION METHOD
					FILTER PACK QTY.
					FILTER PACK TYPE
					INSTALLATION METHOD
GROUI ITPE		DRILLING MOD TIPE			INSTALLATION METHOD
ELEV./DEPTH	SOIL / ROCK DESCRIPTION	WELL	SKETCH		INSTALLATION NOTES
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EXHIBIT D



FIELD CHANGE REQUEST Job/Task Number: ___ Other Affected Documents: Requested Change: _____ Reason for Change: Change Requested by: _____ Date ____

Reviewed by: __

Comments: ____

GAI Project Manager

_____ Date _____



FIGURE 8-1



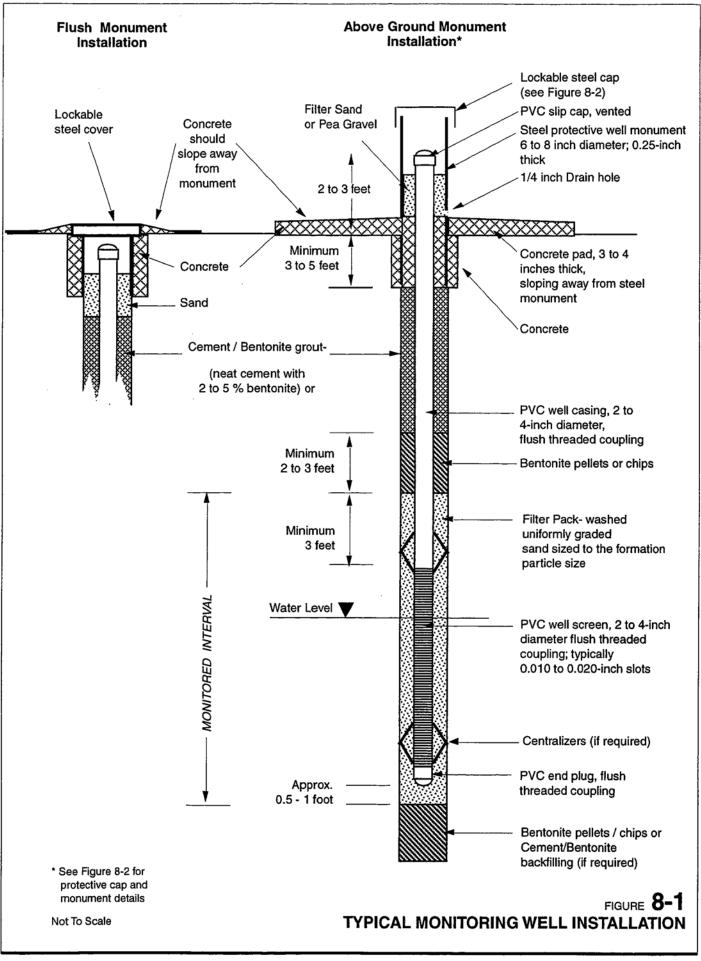
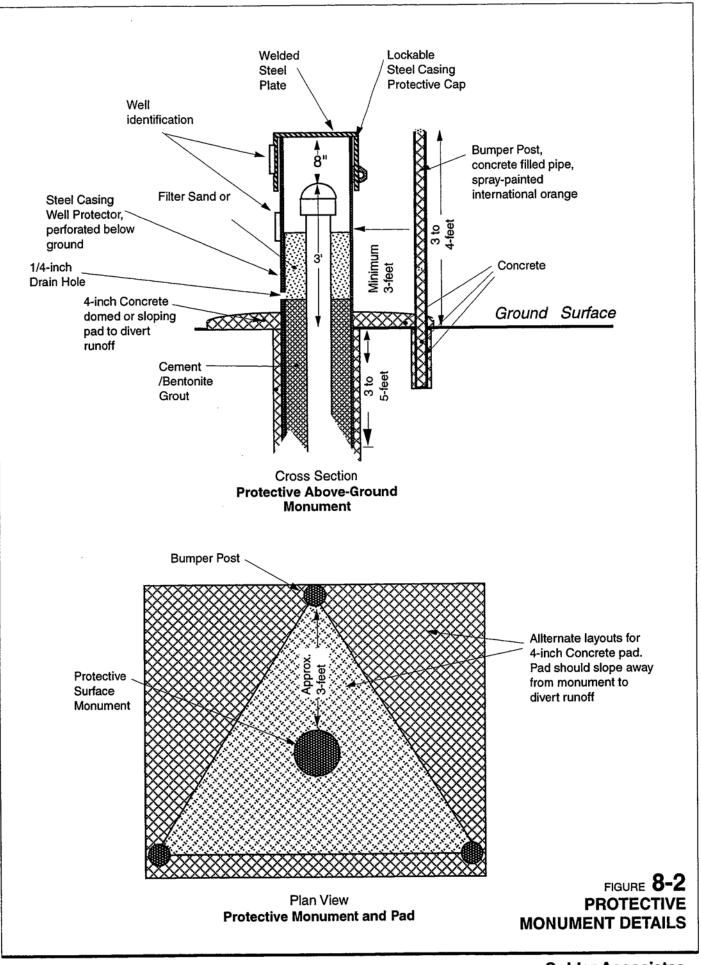




FIGURE 8-2





TECHNICAL GUIDELINE FOR COLLECTION OF GROUNDWATER QUALITY SAMPLES TG-1.2-20

Rev. #3 8/20/2009



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TG-1.2-20 samples

Collection of groundwater quality

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1.0 PURPOSE

This technical training guideline establishes a standard methodology for collecting groundwater samples for chemical analysis that are representative of aquifer water quality.

2.0 APPLICABILITY

This technical training guideline is applicable to field personnel engaged in the collection of groundwater samples from wells for purposes of chemical analysis. This document should be read in conjunction with any and all regulatory, workplan, order, client specific, and other project-specific guidelines.

3.0 DEFINITIONS

3.1. Dedicated Pump System

A dedicated pump system is a permanently installed device for removing water from a well. The system is not removed from the well and does not have the potential to become cross-contaminated between uses.

3.2. Well Bore Storage Volume

Well bore storage volume is defined as the volume of water enclosed by the well casing and screen gravel/sand pack at equilibrium.

3.3. Bailer

A bailer is a tubular device with a check-valve at the top and/or bottom for collecting and removing groundwater from wells.

3.4. Non-Dedicated Sampling Apparatus

Non-dedicated sampling apparatus is sampling equipment that may contact groundwater samples from more than one well. This term is also used to describe equipment that is only used for sampling a single well, but is removed from the well and could potentially become contaminated.

3.5. Groundwater Sample

A groundwater sample is defined as water acquired from a well for analyses of chemical or biological parameters that is representative of groundwater within the aquifer or the portion of the groundwater in the subsurface being sampled.

3.6. Positive Pressure Pump

A positive pressure pump is a device for removing water from a well by forcing water to the surface through positive pressure when operated below the well's water level. A positive pressure pump may be operated electrically, mechanically, or by gas pressure. Submersible impeller, bladder, and check valve pumps are common types of positive pressure pumps.

3.7. Negative Pressure Pump

A negative pressure pump is a device for removing groundwater from a well by suction (negative pressure). Peristaltic and centripetal pumps are common types of negative pressure pumps. The limitation for lifting water by suction is usually 20 to 25 feet. These pumps are typically only acceptable



for non-volatile analytes and analytes that are not affected by aeration or changes in pH or pressure. They are useful as purging devices for shallow groundwater wells.

3.8. Sample Bottles

Sample bottles are containers specifically designed and prepared for storing aliquots of a sample. Sample container type, material, size, and type of lid are specific for particular groups of analytes. Sample bottles must typically be properly cleaned and prepared by a certified laboratory.

3.9. Acceptable Material

Acceptable materials are defined as the only materials that are allowed to contact groundwater samples, and are dependent on the analytes being tested.

3.10. Permissible Pump

Permissible pumps are defined as pump systems that have acceptable effects on water quality when used to obtain groundwater samples from wells. The use of permissible pumps is dependent on the analyses being conducted on the acquired samples. The parts of permissible pumps that will contact the groundwater sample contain only acceptable materials.

4.0 DISCUSSION

In order to generate appropriate, quality data using these guidelines, it is incumbent on the field personnel to have reviewed these guidelines as well as other referenced and/or pertinent technical guidelines. This document should be read in conjunction with any and all regulatory requirements, site-specific work plans, administrative orders, and client-specific or other project-specific guidelines.

Groundwater samples shall be collected in quantities and types as directed by the Project Manager and project work documents. If applicable, sampling or monitoring shall be conducted for any potential floating immiscible layers prior to well purging and sampling. All instruments used for field analyses shall be calibrated in accordance with appropriate guidelines. The guidelines in Golder Associates Quality Procedure QP-1, "Calibration and Maintenance of Measuring and Test Equipment" may be applicable, however it is important to be familiar with local regulatory and project-specific requirements.

All non-dedicated sampling equipment shall be decontaminated before and after each use. If directed by the Project Manager or as specified in project work documents, purge water and decontamination fluids shall be captured and contained for disposal. Samples shall be collected in properly prepared containers of the appropriate size and type (see Table 1). All samples shall be appropriately labeled and sealed (see Exhibit A) an appropriate groundwater sample collection forms (Exhibit B) must be used to document raw field information for each sample. Chain of custody (see Exhibit C) shall be maintained in accordance with guideline TG-1.2-23, "Chain of Custody." The Field Report Form (see Exhibit D) and Sample Integrity Data Sheet (see Exhibit E) and bound field notebooks shall be used to document daily site activities and sample collection. All variations from established guideline shall be documented on the Field Change Request (see Exhibit F) and shall be approved by the Project Manager.

5.0 RESPONSIBILITIES

5.1. Sampling Technician

The Sampling Technician is responsible for sample collection, sample custody in the field, preservation, field testing, total and accurate completion of data sheets, sample shipment and delivery of data to the Project Manager, all as described in this technical guideline.



5.2. Task Leader

The Task Leader is responsible for supervising Sampling Technicians. Supervision includes ensuring that samples are collected, documented, preserved, field analyzed, handled and shipped to the appropriate laboratory as specified in project work documents and this technical guideline. In many cases, the Task Leader will also fill the role of the Sampling Technician.

5.3. Project Manager

The Project Manager has overall management responsibilities for the project, is responsible for designing the sampling program, for arranging the logistics of the program, and for providing any required clarifications in the use of this guideline.

6.0 EQUIPMENT AND MATERIALS

If wells are equipped with permissible and dedicated pump systems, equipment to operate the dedicated pump systems (i.e., air compressor, compressed air or nitrogen cylinders, electric generator, etc.); non-dedicated sampling apparatus such as surface discharge tubing and valving; or bailer(s) for sampling free floating product may be necessary.

If wells do not have permissible and dedicated pump systems, permissible pump systems or bailers and accessories of small enough diameter to enter the wells will be necessary. All equipment that could contact the sample shall be made of acceptable materials.

Additional supplies should include: sample bottles, properly cleaned and prepared by a certified laboratory with preservatives appropriate for the parameters to be sampled.

Field test equipment

- multi parameter meter and calibration standards (meter should be capable of measuring pH, specific conductance, redox, dissolved oxygen and temperature);
- turbidity meter and calibration standards;
- flow through cell for collection of field measurements;
- Filtration apparatus (0.45 micron and prefilter), if necessary;
- Depth to water measuring device;
- Interface probe if necessary;
- Well specifications;
- Sample labels and seals (Exhibit A);
- Groundwater Sample Collection Forms (Exhibit B);
- Chain of Custody Forms (Exhibit C);
- Field Report Forms (Exhibit D);
- Sample Integrity Data Sheet (Exhibit E);
- Coolers and ice packs or wet ice contained in zippered plastic bags;
- HPLC/distilled/deionized/Type II water as necessary;





- Isopropyl alcohol;
- 1% solution of trace metal grade nitric acid;
- Cleaning equipment and solutions;
- Indelible ink pens;
- Field notebooks;
- Container(s) for capturing, containing, treating and measuring waste decontamination solutions, if necessary;
- OVA or OVM with accessories and calibration gases;
- As required, 55 gallon steel drums fitted with bung holes, or suitable vessels(s) for containing purged groundwater;
- Field Change Request (Exhibit F);and
- Appropriate PPE, notably suitable gloves for handling samples. Various gloves may react to potential contaminants, so glove selection should be made carefully prior to mobilizing to the field.

7.0 GUIDELINE

7.1. General Considerations

7.1.1. Regulatory Considerations

At most locations, groundwater sampling and the characterization and disposal of purge fluids are specifically regulated by local, or state regulations, or may have client specific requirements. All such client and regulatory requirements must be reviewed before groundwater sampling. At a minimum, the following actions must be taken:

Ensure that groundwater sampling is performed by an entity that meets all requirements for conducting such operations in that particular location; and

Ensure that all follow up well reports required by appropriate agencies are submitted to the appropriate authorities or in some cases that we have informed the client of such requirements.

7.1.2. Decontamination

All non-dedicated sampling equipment that may contact the sample must be decontaminated before and after each use. Non-dedicated pumps or bailers require decontamination of internal and external parts prior to being lowered into the well. Non-dedicated equipment shall typically first be washed with clean tap water (whose chemistry is known and acceptable), non-phosphate detergent (e.g., Alconox), and rinsed with clean tap water. For inorganic analytes 1% nitric acid solution shall be used for a second rinse. For organic analytes, reagent-grade isopropyl alcohol is often used for the second rinse. A final rinse with HPLC/distilled/deionized/Type II water shall complete the decontamination. At a minimum, all acid and isopropyl alcohol wash solutions must be captured (see Section 7.4.2).





7.1.3. Sample Quantities, Types, and Documentation

Samples shall be collected in quantities and types as directed by the Project Manager or as specified in the project work documents. The Field Report Form (Exhibit D) or field notebook and the Sample Integrity Data Sheet (Exhibit E) shall be used to document daily site activities and sample collection (see Section 7.5). Samples shall be transferred to the analytical laboratory under formal chain of custody, which shall be documented (Exhibit C) and maintained in accordance with guideline TG-1.2-23, "Chain of Custody".

7.1.4. Sample Containers

Table 1 provides a summary of the typical type and minimum size of the sample bottles, preservation, storage/handling requirements, and maximum holding times for some common chemical analyses performed on groundwater samples for environmental investigations. All sample bottles must be properly cleaned and prepared by a certified laboratory. All groundwater samples shall be labeled and typically sealed (see Section 7.5) and immediately placed in coolers that have been pre-cooled to 4°C or less and that have securely closed lids for storage and transport. Samples must be received by the analytical laboratory in sufficient time to conduct the requested analyses within the specified holding time. All samples should be placed on ice and stored at 4°C immediately following sampling unless otherwise indicated in the site-specific work plan.

7.1.5. Acceptable Materials

The choice of materials used in the construction of sampling devices should be based upon knowledge of what analytes may be present in the sampling environment and how the sample material may interact.

Typically acceptable materials that may contact groundwater sample are stainless steel and fluorocarbon resin (Teflon, PTFE, FEP, or PFA). Glass is an acceptable material for contacting some samples. Plastics (PVC, polyethylene, polypropylene, tygon) are an acceptable material for contacting some samples, often when the analyses are for inorganic analytes (metals, radionuclides, anions, cations).

7.1.6. Sample Acquisition

Groundwater samples shall typically be removed from the well with the use of a permissible pump or bailer. Electric positive-pressure pumps made of acceptable materials as defined in Section 3.0 are permissible to use for acquiring any groundwater sample. Gaseous, typically air or nitrogen pressure activated positive-pressure pumps made of acceptable materials are permissible to use for acquiring any groundwater sample if the gas does not contact the sample. Positive-pressure pumps operated by mechanically forcing water through check valves are often permissible for acquiring any groundwater samples. Bailers made of acceptable materials are permissible for acquiring groundwater samples in some circumstances.

Peristaltic pumps and air-lift pumps are not preferred for acquiring groundwater samples but are often permissible when samples are to be analyzed for analytes that are not affected by aeration, and are not affected by changes in pH or pressure.

Other types of pumps (peristaltic, centrifugal, air lift, recirculation, etc.) may typically be used for purging groundwater from wells prior to sample acquisition, if: (1) pump materials contacting well water are acceptable; (2) pumping does not aerate or change the pH of the remaining well water; and (3) pumped water does not mix with remaining well water during pumping or after the pumping is stopped.



The appropriate pump should be selected by the Project Manager prior to mobilizing to the field.

7.2. Groundwater Sample Acquisition

7.2.1. Floating or Sinking Non-Aqueous Fluids

Groundwater shall be examined for the presence of any floating or sinking non-aqueous fluids, in unknown situations or where they may be potentially present, at the direction of the Project Manager. If detected, they shall be sampled prior to purging any water from the well. An interface probe is often used for this purpose along with measurement of the liquid/water level. Guideline TG-1.4-6, "Water Level Measurement" may be applicable. A bailer (preferably with a check valve at the bottom only and made of transparent Teflon or glass) may be lowered into the well to retrieve a sample of floating non-aqueous fluid. The bailer shall not become completely submerged. A sample of sinking non-aqueous fluid can often be obtained using a stainless steel device designed specifically for discrete interval sampling. If a non-aqueous fluid is sampled, it may be transferred to a 40 ml or 125 ml glass vial with an air-tight, Teflon-lined septum cap. The sample shall not be filtered or preserved with additives, but shall typically be placed in a metal can with vermiculite and then in a cooler that has been pre-cooled to 4°C and secured for storage and transport. There are often very stringent requirements for transport of such samples.

7.2.2. Purging the Well

It is often preferable to conduct well purging using a low flow/low stress methodology. Purging shall be conducted by starting the pump at its lowest setting and slowly increasing the pumping rate until flow occurs (typically flow rates on the order of 0.1 to 0.4 l/min). Ideally at this pumping rate, there should be a minimum level of water level drawdown (generally less than 10 cm). Monitor and record the pumping rate and water level as appropriate during purging. During purging, monitor indicator field parameters (e.g., turbidity, temperature, specific conductance, pH, ORP, DO) every three to five minutes. Purging is considered complete and sampling may begin when the indicator parameters have stabilized. Stabilization is considered to be achieved when three consecutive readings, taken on 3 to 5–minute intervals, are within the following tolerance:

- Turbidity (within 10% and preferably less than 5 NTU);
- Temperature (within 0.5 degrees C):
- Specific conductance (within 10%);
- pH (within 0.1 stnd pH units);
- ORP (within 10%); and
- **DO** (within 10%).

If the low flow/low stress methodology is not used, the pump or bailer shall be used and operated in accordance with the manufacturer's operational manual. Before collecting the actual groundwater sample field parameters of at least pH, redox, temperature, and specific conductivity should come to stabilize or approach asymptotical values. In general this will require that a minimum of three (3) well bore storage volumes of water shall be purged from the well by pumping. Calculate this volume by measuring the depth to water and subtracting this depth from the total depth of the well. If a gravel/sand pack surrounds the screen the pore volume of the gravel/sand pack (assume a porosity of 25 percent if unknown) shall be added to the total well volume. While purging water from the well, parameters specified by the Project Manager will be monitored.



A flow-through cell is advantageous for the monitoring of field indicators. Typically, if the parameters are within the ranges specified above, then the water has stabilized. Rarely are more than ten well volumes removed before sampling using these criteria. If the parameters of interest in the investigation include VOCs, care must be taken to ensure that purging does not induce degassing within the well. Where the well screen and sand pack are completely below the water table, the rate of purging should be controlled such that it does not draw the water level in the well below the top of the well screen. Where the well screen and sandpack are intersected by the groundwater level, the rate of purging should correspond with the rate of sampling, if continuous sampling methods are used. Large drawdowns in water table wells should be avoided. Purged groundwater that has a reasonable potential of containing hazardous substances shall be captured and characterized prior to discharge or disposal (see Section 7.4.1). Where a low yielding well is encountered, the Project Manager shall be contacted for direction (see Section 7.6).

7.2.3. Samples for Major Cation, Metal and Metallic Radionuclide Analyses

Samples for major cations and metallic radionuclide analyses are sometimes filtered immediately or within two hours after acquisition. However, most projects require that samples for cations are not filtered. Filtration is best accomplished with the use of an in-line filter system in which the sample is directly fed from the discharge port of permissible positive-pressure pump through the filter and into the appropriate sample bottle. A less preferred but acceptable method is the collection of an adequate amount of sample from a permissible positive-pressure pump or bailer into a properly cleaned and prepared high-density linear polyethylene or glass prefiltration bottle. The prefiltration bottle does not contain any chemical preservative. Aliquots shall be immediately fed through the filter and collected directly into the appropriate sample bottle. The final filter pore size should typically be 0.45 microns. (Note: New filters made of material specified by the Project Manager shall be used for each sample and the filter system must be decontaminated before and after each sample.) These groundwater samples shall be preserved with nitric acid (HNO3) to a pH less than 2. A new capillary tube can be used to remove fluid from the bottle and dabbed onto pH indicator paper to check that the pH is less than 2.

An unfiltered aliquot of a sample can typically be obtained (in addition to the filtered aliquot) directly from a permissible positive-pressure pump discharge port or from the bailer into appropriate sample bottles (see Table 1) and preserved with nitric acid to a pH less than 2. Note that for various cations, including chromium VI, no acid and typically no other chemical preservative is added to the aliquot.

7.2.4. Samples for Semi-Volatile Organics Including Extractable Base-Neutral/Acid Compounds, Phenolic Compounds, Pesticides, PCBs and Herbicides

Samples for semi-volatile organics including extractable base-neutral/acid compounds, phenolic compounds, PCBs, pesticides, or herbicides analyses shall typically be collected directly from a positive-pressure pump discharge port or bailer in appropriate sample bottles often with a Teflon lined lid and in some cases an appropriate chemical preservative. Sample should not be allowed to overflow the sample bottle and in the vast majority of cases shall not be filtered unless specified in a project-specific work plan.

7.2.5. Samples for Purgeable Volatile Organics

Samples for purgeable volatile organics are obtained before samples for other analytes have been acquired for each well. In wells with low productivity, volatile organics should be the first samples taken, unless otherwise directed by the Project Manager. Samples for purgeable volatile organics shall typically be obtained from the well using a permissible positive-pressure pump or bailer and shall be collected directly from the pump discharge tube or bailer into properly cleaned and prepared 40 ml vial.



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Collection of groundwater quality

The sample should not be allowed to overflow the sample bottle as this may remove acid preservative that is usually added at the laboratory either prior to sample shipment to the field or by field staff before filling the vials. The pH of the aliquot should be checked if acid preservative is used and the buffering capacity of the groundwater is high or unknown or more turbid than usual from a carbonate rich strata. A new capillary tube can be used to remove fluid from the bottle and dabbed onto pH indicator paper to check that the pH is less that specified by the methodology for acid preserved samples – often less than pH 2.

Air contact and sample agitation should be minimized. Pumping rates should be significantly reduced during sampling for volatile organics to reduce potential agitation of the sample. These samples shall not be filtered or preserved except as noted below. The bottle should be filled until there is a convex meniscus to facilitate an airtight seal when capped. Immediately after collection, a Teflon lined silicon septum cap shall be placed Teflon side down tightened onto the vial. There should be no air bubbles remaining within the vial once the cap has been fastened; if air is present, a new sample shall be taken by the same guideline.

Samples for many volatile methods are preserved with hydrochloric acid (HCl) to increase holding time. However, in some waters the acid will react with the sample producing bubbles due to production of carbon dioxide or sulfur compounds. If bubbles are found due to reactions with the acid, contact the Project Manager if this eventuality has not been described in the work plan. The Project Manager may require that samples are taken without acid preservative with the resulting shorter holding times. In this case a new unpreserved vial should be used. An unpreserved sample vial can be obtained by pouring the acid out of a preserved vial if no unpreserved vials are available. It is unlikely that the remaining acid will be sufficient to produce bubbles. However, if bubbles are still found one may slowly fill and empty the vial once or more times to remove the remaining acid. Samples that are not preserved should be noted as such on both the bottle labels and the Chain of Custody documents.

7.2.6. Samples for Cyanide Analyses

Samples for cyanide analyses shall be collected directly into appropriate sample bottles from the bailer or the port of a permissible positive-pressure pump. Samples shall not be filtered nor shall they be allowed to overflow the sample bottle. A pre-preserved bottle is typically made available. Otherwise, samples shall be immediately preserved with sodium hydroxide (NaOH) to a pH greater than 12. A new capillary tube can be used to remove fluid from the bottle and dabbed onto pH indicator paper to check that the pH is greater than pH 12.

7.2.7. Samples for Major Anion and Biological Oxygen Demand (BOD) Analyses

Samples for major anions (chloride, fluoride, sulfate, alkalinity, acidity, total silica, bromide) and for biological oxygen demand shall be collected directly into appropriate sample bottles from the port of the pump or from the bailer. These samples do not require filtration, but may be filtered if explicitly required in the sampling plan. Chemical preservatives shall only be added as required by the method.

7.2.8. Samples for Total Phosphate and Orthophosphate Analyses

Groundwater samples for total phosphate and orthophosphate analyses shall typically be immediately filtered after initial sample acquisition. However, these parameters often are specified to be taken without filtration. Filtration is best accomplished with an in-line system in which a positive-pressure pump discharge port feeds groundwater directly through the filter system into an appropriate sample bottle. A less preferred but acceptable method to obtain a filtered sample is to collect a liter of sample from a permissible positive-pressure pump or bailer in a properly cleaned and prepared high-density



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Collection of groundwater quality

polyethylene or glass bottle, and then immediately feed the sample through a filter system (e.g., syringe filters) which discharges into the appropriate sample bottle. This process should be completed within two hours; otherwise, the results will be suspect. The final filter pore size shall typically be 0.45 micron. (Note: New filters made of most any material must be used for each sample and the filter system must be decontaminated before and after each use.) Samples shall be immediately placed on ice and preserved by cooling to 4°C or lower.

7.2.9. Samples for Total Phosphorus, Nitrogen Compounds, Chemical Oxygen Demand, Total Organic Carbon, and Total Organic Halogen Analyses

Groundwater samples for total phosphorus, nitrogen compounds, chemical oxygen demand, and total organic carbon analyses shall be collected directly into appropriate sample bottles from a permissible positive pressure pump discharge port or from the bailer. These samples shall not be filtered and shall be chemically preserved as required by the various methods.

7.2.10. Samples for Analysis of Total Dissolved Solids

Groundwater samples for analyses of total dissolved solids shall be immediately filtered in the field by methods discussed in Section 7.2.3 above or collected without filtration depending on sampling plan, and put directly into an appropriate sample bottle. Samples shall not be preserved with chemicals.

7.2.11. Samples for Oil and Grease or Hydrocarbons

Groundwater samples for oil and grease or hydrocarbons shall be collected directly into the appropriate sample container from the discharge port of a permissible positive pressure pump or from the bailer. These samples shall not be filtered and in some cases shall be preserved with hydrochloride acid (HCL, 1 + 1 Vol/Vol) to a pH less than 2. A new capillary tube can be used to remove fluid from the bottle and dabbed onto pH indicator paper to check that the pH is less than 2. Do not preserve with sulfuric acid due to potential interferences in the analytical procedure from co-extraction of elemental sulfur.

7.2.12. Samples for Fuel Fingerprinting

Groundwater sample for fuel fingerprinting shall be collected directly into the appropriate sample container using a permissible positive pressure pump or bailer and shall be collected directly from the pump discharge tube or bailer. Some guidelines require that the sample be allowed to overflow approximately 2 to 3 sample container volumes minimizing agitation and contact with air. These samples shall not be filtered but typically must be preserved to a pH <2 with HCL (1:1 vol/vol). A new capillary tube can be used to remove fluid from the bottle and dabbed onto pH indicator paper to check that the pH is less than 2. The sample container is then often capped with a Teflon lined silicon septum cap excluding all headspace. Otherwise the sample is often split into two or three aliquots for different analyses as dictated in the sampling plan or as specified by the Project Manager.

Field Analyses 7.3.

7.3.1. Calibration of Instruments

All instruments used for field analyses shall be calibrated in accordance with guidelines required by the sampling and analysis plan; or by the most strict single guideline or combination of guidelines compiled from procedure QP-1, "Calibration and Maintenance of Measuring and Test Equipment;" or by the method or manufacturer's procedure. Only equipment with a calibration tag showing a validity date later than the anticipated date of use shall be taken to the field unless, as is usual, field calibration is performed. Each





instrument should be accompanied by a copy of the manufacturer's operation manual and appropriate instrument calibration records.

7.3.2. Water Temperature

A meter and a flow though cell are the preferred tools for measuring this parameter. The meter shall be calibrated in accordance with the sampling plan, and if more stringent, with the manufacturer's procedures (provided with the instrument). If a meter is unavailable, a thermometer shall be used to measure the temperature of the water on an aliquot of purged water obtained just before sampling. The thermometer reading shall be allowed to stabilize and shall be recorded to the nearest 0.5°C. The thermometer shall be rinsed with distilled/deionized water before and after each use.

7.3.3. pH Measurement

A meter and a flow though cell are the preferred tools for measuring this parameter. Alternately, a pH meter may be used to measure the pH of the sample on an aliquot of purged water that was obtained just before sampling. Measurements shall be made immediately on the obtained aliquot. (Note: If possible, measure pH continuously on the purged water in an air-space free and closed flow-through system.) Calibration shall be in accordance with the sampling plan or, if more stringent, with the manufacturer's procedures (provided with the instrument). At a minimum, calibration shall be performed at the beginning and ending of each day's use and every four hours in between. Calibration shall be performed with standardized buffered pH solutions and conducted as required by the more stringent of the sampling plan or manufacturer's specifications. Typically, the probe shall be thoroughly rinsed with distilled/deionized water after each sample when using a flow through cell or after each sample reading when the probe is placed in a discrete aliquot of sample. The pH shall be recorded to one-hundredth, if the meter is stable enough of a pH unit.

7.3.4. Conductivity Measurement

A meter and a flow though cell are the preferred tools for measuring this parameter. Alternately, a conductivity probe may be used for conductivity measurement on an aliquot of purged water obtained just before sampling. Measurements shall be made as soon as possible on the obtained aliquot. The meter shall be calibrated in accordance with sampling plan or, if more stringent with the manufacturer's procedures (provided with the instrument) with standardized calibration solutions. It is preferable to have a range of calibration solutions that bracket the site conductivity range. At a minimum calibration shall be performed at the beginning and ending of each day's use and every four hours in between. The conductivity shall typically be recorded to two significant figures and rarely more than three significant figures. The temperature of the sample at the time of conductivity measurement shall also be recorded. The probe must be thoroughly rinsed with distilled/deionized water before and after each use. It is imperative that the Sampling Technician record the correct units in which the conductivity measurements were taken.

7.3.5. Dissolved Oxygen Measurement

A meter and a flow though cell are the preferred tools for measuring this parameter. Alternately, a dissolved oxygen meter is used to measure dissolved oxygen (DO) in water samples. This test should be at best considered a rough estimation with most meters as the measurements are subject to a number of environmental interferences that may affect the results. Measurements shall be made immediately on aliquots obtained just before sample acquisition. (Note: If possible, measure DO continuously on the purge water in a closed flow-through system.)





The meter shall be calibrated in accordance with the sampling plan or, if more stringent, with the manufacturer's procedures (provided with the instrument). Any salinity adjustment shall be made to the approximate salinity of the water (one may use knowledge of the subsurface or some conductivity meters or dedicated salinity meters to obtain the salinity of the water). The probe must be thoroughly rinsed with distilled/deionized water before and after each use. Measurements shall typically be recorded to the nearest 0.1 ppm concentration.

7.3.6. Turbidity Measurements

A turbidity meter shall typically be used to make turbidity measurements on aliquots of water samples obtained just before sample acquisition. Measurements shall be made as soon as possible on the obtained aliquot. Operation and calibration shall be in accordance with the sampling plan or, if more stringent, with the manufacturer's procedures (provided with the instrument). It is preferable to have a range of calibration solutions that bracket the site turbidity range. At a minimum calibration shall be performed at the beginning and ending of each day's use and every four hours in between. Calibration shall be performed with calibration solution specified for the project. Measurements shall be recorded to the nearest 0.1 NTU when less than 1 NTU; the nearest 1 NTU when between 1 and 10 NTU; and the nearest 10 NTU when between 10 and 100 NTU.

7.3.7. Redox Potential Measurements

A meter and a flow though cell is a preferred way to measure this parameter. Alternately, a redox meter may be used to obtain redox potential measurements. However, there are many other ways to measure redox couples. When a meter is used the reading should be obtained on an aliquot of purged water that was obtained just before sampling. Measurements shall be made immediately on the obtained aliquot. (Note: The best results using a redox meter usually come from measuring the redox on the purged water in an air-space free and closed flow-through system.) Calibration and operation shall be in accordance with the sampling plan and if more stringent with the manufacturer's procedures (provided with the instrument). It is preferable to have a range of calibration solutions that bracket the site redox potential range. At a minimum calibration shall be performed at the beginning and ending of each day's use and every four hours in between. Calibration shall be performed with calibration solution specified for the project. Typically, the probe shall be thoroughly rinsed with distilled/deionized water after each sample when using a flow through cell or after each sample reading when the probe is placed in a discrete aliquot of sample. The redox using a probe shall be recorded in millivolts to the number of significant figures required by the sampling plan - which is typically three significant figures.

7.4. Capture and Disposal of Purge Water and Decontamination Solutions

7.4.1. Purge Water

Purged groundwater shall be handled as specified in the sampling plan. Typically purge water will be captured and contained in 55-gallon steel drums or suitable vessel(s). If required, each drum or tank containing captured purge water shall be properly labeled with a weather proof label as to the contents, the well(s) from which the contained purge water originated and the date in which the contents were generated. Storage of the drums or tanks shall be as specified in the project work documents or as directed by the Project Manager. In many cases there is specific wording required for the labels and this should be found in the sampling plan.

Captured and contained purge water shall be characterized for discharge, treatment and/or disposal. Characterization of the captured and contained purge water should be specified in the sampling plan or other project work documents or by the Project Manager, but could rely on site knowledge, the analytical results of groundwater samples associated with each drum or other vessel, or could involve direct sampling and analyses of the contained water.



The requirements and options available for discharge, treatment and/or disposal are dependent upon many variables such as client requirements, chemical consistency, local and state and other regulations and location of site. Discharge, treatment and/or disposal of captured and contained purge water must be in accordance with all applicable requirements such as, but not limited to, client specific procedures. Local, state and Federal regulations and shall be specified in the sampling plan or in other project work documents.

7.4.2. Decontamination Waste Solutions

Decontamination waste solutions that are generated during groundwater sampling include: spent detergent wash solutions; spent tap water rinses; any spent acid or alkali rinses, any spent organic (such as isopropyl alcohol) rinses; and spent final distilled/deionized water rinses. All decontamination waste solutions shall be captured and contained in appropriately sized vessels as required by the sampling plan or other project documentation. In any cases where this is not clear, the Project Manager shall be contacted so they can determine (with input from others as needed) whether spent decontamination solutions require capture and containment.

Captured and contained decontamination waste solutions shall be subject to requirements of the sampling plan or other project documentation. These are often generally the same guidelines as described for purge water. A noteworthy typical requirement is that all acid and alkali solutions shall be neutralized prior to discharge or disposal.

7.5. Documentation

Documentation for sampling groundwater includes labeling sample bottles; and other requirements as specified by the sampling plan or other project documentation. These further requirements often include project field notebooks, Sample Integrity Data Sheets, Field Report Forms, and Chain of Custody Records; additional documentation requirements may warrant securing individual samples or sample coolers with chain of custody seals.

7.5.1. Sample Labels

Samples shall be immediately labeled (see Exhibit A for an example label). Labels shall be water proof. Information shall be recorded on each label with indelible ink. All blanks shall be filled in (N/A if not applicable). Groundwater sample designations will be as specified in the project work documents or by the Project Manager. At a minimum the following information is required upon the label: Site name, sample ID, parameter(s) to be tested, sample date and time, sampler's initials, chemical preservative, if used.

7.5.2. Groundwater Sample Collection Forms

Groundwater Sample Collection Forms (Exhibit B) are used by the Sampling Technician to document the official raw field information for each sample that will be chemically analyzed. All blanks shall be filled in (N/A if not applicable). The original must be submitted as soon as possible to the Project Manager. Copies must be sent to the Task Leader (if appropriate).

7.5.3. Chain of Custody Records

Chain-of-Custody Records (Exhibit C) will be used to record the custody and transfer of samples in accordance with guideline TG-1.2-23, "Chain of Custody." These forms shall be filled in completely (N/A if not applicable). Tamper-proof Seals (Exhibit A) shall be placed on either sample bottles or shipping coolers. The seal number shall be recorded on the Chain of Custody Form. The original form must accompany the samples to the analytical laboratory to be completed and returned to Golder in the



analytical data report. A copy of the Chain of Custody Record documenting the transfer of samples from the field must be submitted to the Project Manager.

7.5.4. Field Report Forms

Field Report Forms (Exhibit D) or project field notebooks shall be used by the Sampling Technician to record daily activities. Data shall be recorded on the Field Report Form in chronological format. The time of each recorded event shall be included. The original Field Report Form must be submitted as soon as possible to the Project Manager. Copies must be given to the Task Leader.

7.5.5. Sample Integrity Data Sheet

Sample Interity Data Sheets (Exhibit E) shall be used by the Sampling Technician to record raw field information for each sample that will be chemically analyzed. This data sheet can be used as a supplement to but not in lieu of a groundwater sample collection form. The original must be submitted as soon as possible to the Project Manager. Copies must be given to the Task Leader.

7.6. Field Change Request

Variation from established guideline requirements may be necessary due to unique circumstances encountered on individual projects. All variations from established guidelines shall be documented on Field Change Request (Exhibit F) and reviewed by the Project Manager.

In lieu of requirements in the sampling plan or other project documentation, the Project Manager may authorize individual staff to initiate variations as necessary. If practical, the request for variation must be reviewed by the Project Manager or their designee prior to implementation. All completed Field Change Requests will be maintained in project records.

8.0 REFERENCED GUIDELINES

Golder Associates Inc. Quality Procedure QP-1, "Calibration and Maintenance of Measuring and Test Equipment."

Golder Associates Inc. Technical Guideline TG-1.2-23, "Chain of Custody."

Golder Associates Inc. Technical Guideline TG-1.4-6, "Water Level Measurement."

9.0 ADDITIONAL GUIDELINES AND PROCEDURES

Wood, W.W. (1976), "Guidelines for Collection and Field Analysis of Ground-Water Samples for Selected Unstable Constituents," Techniques of Water-Resources Investigations of the United States Geological Survey, Book 1, Collection of Water Data by Direct Measurement, Chapter D2.

U.S. EPA, 1986, Test Methods for Evaluating Solid Waste - (SW-846), 3rd Edition (Final Update III, December 1996), U.S. EPA/Office of Solid Waste, Washington, D.C.

40 CFR 136, U.S. EPA, Guidelines Establishing Test Procedures for the Analysis of Pollutants. Title 40 Part 136 of the Code of Federal Regulations.

U.S. EPA, 1986, RCRA Ground-Water Monitoring Technical Enforcement Guidance Document, U.S. EPA/Office of Solid Waste, Washington D.C.





40 CFR 141, U.S. EPA, National Primary Drinking Water Regulations, Title 40, Part 141 of the Code of Federal Regulations.

Various EPA Region and State Standard Operating Procedures

Golder Associates Technical Guideline TG-2.3-3, "Headspace Analysis Using the Organic Vapor Analyzer"





Collection of groundwater quality



TABLE 1



TABLE 1

SAMPLE CONTAINER CODES, TYPES, VOLUMES, PREPARATION, SPECIAL HANDLING, PRESERVATION, HOLDING TIMES
Page 1 of 2

Analysis	Cont. Code	Containers, Water	Handling and Preservation	Holding Time
Volatile Organics	v	2, 40ml glass vial teflon lined septum	Store 4±2°C; handle upwind from euip. Fumes, no headspace permitted; Pres with HCl to pH <2 for volatile aromatics	7 days 14 days (HCl pres.)
Base/Neutral and Acid Extractable Organics	sv	2, 1 liter amber glass, teflon lined cap	Store 4±2°C; handle upwind from equip. fumes; no contact with plastics, gloves 7 days until extraction 40 days thereafter	
Organiochlroine Pesticides and PCBs	P	2, 1 liter amber glass, teflon lined cap	Store 4±2°C; handle upwind from equip. fumes; no contact with plastics, gloves	7 days until extraction 40 days thereafter
Herbicides	Н	2, 1 liter amber glass, teflon lined cap	Store 4±2°C; handle upwind from equip. fumes; no contact with plastic, gloves	7 days until extraction 40 days thereafter
Total Fuel Hydrocarbons (Fuel Fingerprint)	TH	1, 125 ml amber glass, teflon lined septum	Store 4±2°C; handle upwind from equip. fumes, no headspace permitted; pres with HCl to pH <2	14 days
Total Petroleum Hydrocarbons or Oil and Grease	OG	1, 1 liter glass, teflon lined cap	Store 4±2°C; handle upwind from equip. fumes, no contact with gloves or plastics; pres with HCl to pH <2	28 days
Cyanide (total)	CN	1,1 liter plastic	Store 4±2°C; pres with NaOH to pH >12	14 days
Suflide (total)	S	1, 1 liter plastic	Store 4±2°C; pres with ZnOAC/NaOH to pH >12	7 days
Chloride, Sulfate, pH Conductivity and Total Dissolved Solids	МА	1,1 liter plastic	Store 4±2°C.	28 days (Chloride, sulfate and conductivity) Analyze on-site (pH) 7 days (TDS)

TABLE 1

SAMPLE CONTAINER CODES, TYPES, VOLUMES, PREPARATION, SPECIAL HANDLING, PRESERVATION, HOLDING TIMES, Page 2 of 2

Analysis	Cont. Code	Containers, Water	Handling and Preservation	Holding Time
Major Cations and Metals (Except Mercury)	TM	1,1 liter plastic	0.45 um filter, pres with HNO ₃	6 months
Mercuryy	•		to pH <2	
Mercury	HG	1,500 ml plastic	0.45 um filter, pres with HNO ₃	28 days
			to pH <2	in the second se
Gamma Emitting Radionuclides	GR	2, 1 liter plastic	0.45 um filter, pres with HNO₃	6 months
			to pH <2	(record exact date/time of sampling for calculation of half-life decay)
Alpha Emitting Radionuclides	AR	2, 1 liter plastic	0.45 um filter, pres with HNO ₃	6 months
			to pH <2	(record exact date/time of sampling for calculation of half-life decay)
Beta Emitting Radionuclides	BR	2, 1 liter plastic	0.45 um filter, pres with HNO ₃	6 months
			to pH <2	(record exact date/time of sampling for calculation of half-life decay)
Total Phosphorus, Ammonia-N,	TP	1, 1 liter plastic	Store 4±2°C; pres with H ₂ SO ₄	28 days
Nitrate/nitrite-N, COD and TOC			to pH <2, store in dark	
Orthophosphate	OP	1, 1 liter plastic	0.45 um filter, store 4±2°C	48 hours



Collection of groundwater quality



EXHIBIT A



Golder
Location Date Date Date Boring No Sample No Depth Blows Description
Driller Engr.

Sample Label

Golder Associates Seal Number 2455



Sent By:

Date: _____

Tamper Proof Seal



Collection of groundwater quality



EXHIBIT B



WATER SAMPLE FIELD INFORMATION FORM

Site:								
Location:								
Project Nu	mber:						f older	•
Sampling 7	Team:					VAS	socia	tes
Sample P	oint ID:			(we	II)			
-					•	vice: Teflon Ba i	ler & Nylon F	Rope
Depth to w	ater befo	re purging (ft-b	omp)		Date:	Time	:	
Sounded w	ell depth	(ft-bmp)			PID rea	ading (ppm)		
As-built we	ell depth (ft-bmp)				Casing Vol	ume Calculation	า
Casing dia	meter (in))			2	." 4"	6"	8"
Casing vol	ume (gal)	1			0.163	gal/ft 0.653 gal/f	t 1.47 gal/ft	2.61 gal/ft
Volume pu	rged (gal)		Time	e Start:		Time Finish:	
Depth to w	ater after	purging (ft-bm	np)	Pur	ge Calc:		-	
Remarks:								
WELL INS	PECTION	<u>1</u>		(Circle	Y or N)			
Is well loca	ition corre	ect on map?	Y or N		Is the	well locked?		Y or N
Is well loca		•	Y or N		Is the	lock in good cond	lition?	Y or N
Is well read	dily acces	sible?	Y or N		Is the	well vented?		Y or N
Is well legil	-		Y or N		Does	casing have weep	hole?	Y or N
Is well prot			Y or N			well have dedicat		Y or N
Is casing fr			Y or N			well have dedicat		Y or N
Is protectiv	e casing	secure?	Y or N		Is equ	ip. in good condit	ion?	Y or N
Remarks:								
		FIELD N	<u>MEASUREM</u>	<u>ENTS</u>		<u>Units</u>	Calibrat	tion Notes
Time	1)	2)	3)	4)	5)			
Temp.	1)	2)	3)	4)	5)	<u>•С</u>	Calibration	time:
рН	1)	2)	3)	4)	5)	std. units	Serial#:	
Sp. Cond	1)	2)	3)	4)	5)	mS/cm		
Turbidity	1)	2)	3)	4)	5)	ntu		
D.O.	1)	2)	3)	4)	5)	mg/l		
Redox	1)	2)	3)	4)	5)	<u>mV</u>		
DTW	1)	2)	3)	4)	5)	ft-bmp		
Volume	1)	2)	3)	4)	5)	gallons		
Sample Co	llection N	lotes:						
Weather co	onditions	at time of sam	pling:					
Sample ch	aracterist	ics:						
Sample da	te / time:			Met	hod of sample	collection: Tefle	on Bailer & N	ylon Rope
Analytical I	Paramete	rs:						
Signature:				Come	nany: Goldor	Associates Inc.	Data	
Signature.	n #03027				barry. Golder	naautiales IIIC.	_ Dale.	

LOW FLOW GROUNDWATER PURGE/SAMPLE FIELD INFORMATION FORM

Site										Golder Associates
Location:										Associates
Project N	umber:					Meter/Type/Seri	al #:			
MONITOR	ING WELL ID:					Meter Calibrated	d @:			
Depth to	Water Prior to	Purging	[ft-bmp]:			Sampling Date/7	Γime:			
Well Casi	ng Diameter [i	n]:				Sampler(s):				
Start Time	e (purging):					Sampling Device:				
Purging D	Device:					Sampling Purge Rate:				
Pump inta	ake setting:					Sample Charact	eristics:			
Well Scre	en Interval:					PID Measureme	ent of Well	Headspac	e (ppm):	
As-Built C	Construction W	ell Depth	າ [ft-bmp]:			Analytical Paran	neters:			
Sounded	Well Depth [ft-	bmp]:								
Weather	Conditions:		T			Fe+2 result (field				PM
Time	Temperature	рН	Specific Conductance	Turbidity	Dissolved Oxygen	Redox Potential	Depth To Water	Volume Purged	Approximate Purge Rate	Observations (PID readings, sample characteristics,
		•	Circle One		75	Note - Indicate		J	3	equipment problems, etc.)
[hh:mm]	[°C]	[std]	[S/m] or [mS/cm]	[ntu]	[mg/l]	<u>if (+) or (-)</u> [mV]	[ft-bmp]	[liters]	[ml/min]	
[[0]	լուսյ	[c/m] or [mo/om]	[IIIG]	[9/.]	[•]	[it-bilip]	[IIICI3]	[/]	
Comment	<u>s:</u>		,							
									Signature:	







EXHIBIT C



CHAIN OF CUSTODY RECORD PROJ. NO. SITE/LOCATION NO. SAMPLERS: (Signeture) OF REMARKS (with initials) CON. MEDIA TAINERS STA. NO. DATE TIME SAMPLE IDENTIFICATION Relinquished by: (Signotore/Firm) Date / Time | Received by: (Signature / Firm) Relinquished by: (Signature/Firm) Date / Time Received by: (Signature/Firm) Relinquished by: (Signature/Firm) Date/Time Received by : (Signature / Firm) Relinquished by: (Signature/Firm) Date / Time Received by: (Signature/Firm) Relinquished by: (Signature/Firm) Date/Time Received by: (Signature/Firm) Date / Time Remarks (attachments if necessary)



Collection of groundwater quality



EXHIBIT D



	GOLDER ASSOCIATES	DATE	108 MO
		PRUJECT	
		LOCATION	
		CONTRACTOR	OWNER
	то	WEATHER	YEMP *at AN
		PRESENT AT BITE	•at PM
	THE FOLLOWING WAS NOTED.		
	,		
4 .	•		
		· · · · · · · · · · · · · · · · · · ·	
•			
			+
-			
	COPIES TO		ID RIEIPORT

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Collection of groundwater quality



EXHIBIT E



SAMPLE INTEGRITY DATA SHEET

Plant/SiteSite Location		o
	Sample IL)
	(s)	
Type of Sampler		
Date	Time	
Media	Station	
Sample Type: grab	time composite	space composite
Sample Acquisition Measuremen	nts (depth, volume of static well w	vater and purged water, etc.)
Sample Description		
Field Measurements on Sample	(pH, conductivity, etc.)	
Aliquot Amount	Container	Preservation/Amount
Sampler (signature)		
Supervisor (signature)	Date	

Golder Associates Inc.



Collection of groundwater quality



EXHIBIT F



FIELD CHANGE REQUEST	Golder
Job/Task Number: Procedure Reference: Other Affected Documents:	
Requested Change:	
Reason for Change:	
Change Requested by:	Date
Reviewed by: Project Manager	Date
Comments:	

Golder Associates Inc.

TECHNICAL GUIDELINE FOR CHAIN OF CUSTODY TG-1.2-23 Rev. #2 8/20/2009



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Exhibit A Seals and Labels

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Figure 8-1 Sample Container Packing Arrangement





1.0 PURPOSE

This technical guideline establishes the requirements for documenting and maintaining environmental sample chain of custody from point of origin to receipt of the sample at the analytical laboratory.

2.0 APPLICABILITY

When specifically invoked by project work plans, sampling plans, or QA plans, this technical guideline shall apply to all types of air, soil, water, sediment, biological, and/or core samples to be analytically tested in support of environmental investigations by Golder Associates Inc., and is applicable from the time of sample acquisition until custody of the sample is transferred to an analytical laboratory.

3.0 DEFINITIONS

3.1. Custody

Custody refers to the physical responsibility for sample integrity, handling, and/or transportation. Custody responsibilities are effectively met if the samples are:

- in the responsible individual's physical possession;
- in the responsible individual's visual range after having taken possession;
- secured by the responsible individual so that no tampering can occur; or
- secured or locked by the responsible individual in an area in which access is restricted to authorized personnel.

3.2. Chain of Custody

Chain of custody refers to the history of the physical transfer of samples between the sampler, the transporter, or carrier, and the laboratory technician. Chain of custody documentation is required as evidence that the integrity of samples was maintained during transfer.

4.0 DISCUSSION

Environmental samples must be tracked, handled and transported in a manner such that sample integrity and identification (to the location and interval at which they were obtained) is maintained. The sample custodian must maintain proper storage and custody of samples from the time of collection until transport to the laboratory. The sampler shall initiate Chain of Custody forms which accompany samples from the collection site to the laboratory and provide documentation of any transfer of custody throughout transport. Sample identification and integrity shall be ensured by the application of seals and labels to the sample containers at the time of sample collection. Seals and labels shall be verified upon receipt of samples at the analytical laboratory; unacceptable samples shall be identified on the Chain of Custody form, and referred to the Geologist/Field Engineer or Project Manager for evaluation and appropriate disposition.

5.0 RESPONSIBILITIES

5.1. Project Manager

The Project Manager is responsible for the overall management of environmental sampling activities, for designating the sample shipment method (considering permitted sample holding times), for delegating





sampling responsibilities to qualified personnel, and reviewing any Field Change Requests that may be initiated during the investigation.

5.2. Geologist/Field Engineer

The Geologist/Field Engineer is responsible for: 1) providing general supervision of sampling operations as directed by the Project Manager; 2) ensuring proper temporary storage of samples and proper transportation of samples from the sampling site to the laboratory; and 3) initiating Field Change Requests when required. The Geologist/Field Engineer is also responsible for tracking Chain of Custody forms for samples to ensure timely receipt of the completed original, for reviewing Chain of Custody forms to ensure appropriate documentation of sample transfers, and for advising the Project Manager of any problems observed that are related to sample integrity and chain of custody. The Geologist/Field Engineer may delegate document tracking and review responsibilities to suitably qualified personnel.

5.3. Sampler

The sampler may be the same individual as the Geologist/Field Engineer and is responsible for: 1) sample acquisition in compliance with applicable guidelines and procedures; 2) checking sample integrity and documentation prior to transfer; 3) initiating the Chain of Custody form; 4) maintaining custody of the samples while completing the sampling project; and 5) physically transferring the samples to the transporter or directly to the laboratory.

5.4. Laboratory Sample Custodian

The laboratory sample custodian or designated sample receiving technician is responsible for: 1) inspecting transferred samples to ensure that seals are intact, that labels are affixed, that sample condition is acceptable, and that Sample Integrity Data Sheets are completed, when required for a particular project; 2) completing the Chain of Custody form upon receipt; 3) forwarding copies of the completed Chain of Custody form to the Project Manager; and 4) segregating and identifying unacceptable samples, and subsequently notifying the Golder Project Manager.

5.5. Document Custodian

The document custodian (project manager or administrative assistant) is responsible for maintaining completed Chain of Custody forms in the project files.

6.0 EQUIPMENT AND MATERIALS

- Seals and labels (Exhibit A)
- Sample Integrity Data Sheets (Exhibit B), if required by the applicable sampling procedure, work plan, sampling plan, or quality assurance (QA) plan, or if requested by the Project Manager
- Chain of Custody forms (Exhibit C)
- Field Change Request form (Exhibit D)
- Packing and shipping materials, which may include coolers or insulated packing boxes, ice, "blue ice" or dry ice, cardboard packing boxes, wooden core storage boxes, and shipping labels. If dry ice is used, caution should be used so that samples do not freeze resulting in broken jars and negative impact to other samples in the same carrier.





7.0 GUIDELINE

7.1. Seals, Labels, and Initial Storage

At the time of collection, all samples shall be sealed, labeled, and appropriately stored in the custody of the sample custodian as defined in 3.1 above. Examples of standard seals and labels are included in Exhibit A.

7.2. Sample Packaging

All samples shall be packaged appropriately for shipping to protect them from damage, to ensure that moisture content is maintained where necessary, and to ensure that appropriate temperatures are maintained as required. All sample shipping containers shall be sealed (see Exhibit A) to prevent tampering.

Environmental core sample boxing, marking, and labeling shall be in compliance with TG-1.2-2, "Geotechnical Rock Core Logging." Other types of environmental samples stored in jars or bottles may be packaged in insulated coolers, or, if sample temperature is not a concern, in the original sample container packing boxes. Where cooling is required, samples shall be shipped in insulated coolers containing bagged or pre-packaged ice sufficient to keep the samples at $4^{\circ}C \pm 2^{\circ}$. All samples should be carefully placed in the appropriate container(s) and packaged with paper or bubble-wrap to prevent significant movement or breakage during transport.

Samples from boreholes shall be packaged, where appropriate, by placing the jars in shipping containers from the top right corner downward, and from left to right, beginning with the first sample taken as shown in Figure 8-1. An alternative packaging order may be appropriate to isolate contaminated samples to minimize the risk for cross-contamination.

A label containing the following information should be affixed to the front of each shipping container containing environmental samples:

- Project Number
- Location
- Borehole number(s) (if appropriate)
- Date collected
- Sample numbers enclosed

Boxes should be numbered consecutively; the last box from a borehole or drillhole shall also be identified "EOH," (i.e., end of hole).

7.3. Sample Examination

Prior to transfer of samples, the sampler shall ensure that:

- labels and seals are affixed and completely filled out;
- Chain of Custody documentation corresponds to the samples in the shipment;
- special handling and storage requirements are identified where required;
- Sample Integrity Data Sheets are available where required by applicable sampling guidelines or the Project Manager;





- there are no indications of sample container leaks or other questionable conditions that may affect the integrity of the sample; and
- hazardous and/or radioactive samples are clearly identified as such.

Samples that do not meet the requirements for initial transfer shall be referred to the Geologist/Field Engineer or Project Manager for disposition.

7.4. Chain of Custody Form Initiation

The sampler shall initiate the Chain of Custody form (Exhibit C) for the initial transfer of samples. Chain of Custody forms supplied by the analytical laboratory may be used in lieu of the form shown in Exhibit C. At a minimum, the following information shall be entered on the form:

- the destination of the samples and the transporter or carrier;
- the project identification and sampling site;
- the date and time of sample collection;
- the sample identification numbers and descriptions (e.g., media, container);
- analysis required for samples included in the shipment; and
- QA and reporting instructions for the laboratory.

When all required information has been entered the sampler shall sign and date the Chain of Custody form as the initiator.

7.5. Transfer of Custody

To document the initial transfer of samples, the sampler relinquishing custody and the transporter accepting custody shall sign, date, and note the time of transfer on the Chain of Custody form. If the transporter is not an employee of Golder Associates Inc., the sampler may identify the carrier and reference the bill of lading number in lieu of the transporter's signature. The Chain of Custody form should be in triplicate. One copy of the Chain of Custody form shall be forwarded to the Geologist/Field Engineer by the sampler. The original form and the remaining copy shall accompany the samples.

7.6. Receipt at Destination

The laboratory sample custodian shall inspect the transferred samples to ensure that:

- the seals are intact;
- the labels are affixed and legible;
- Sample Integrity Data Sheets are available where required;
- the physical condition of the samples is acceptable; and
- the samples being transferred directly correspond to those listed on the Chain of Custody form.

If the integrity of the samples is questionable, the laboratory technician shall notify the Golder Project Manager, segregate the unacceptable samples and identify them on the Chain of Custody Form. Otherwise, the laboratory sample custodian and the transporter shall sign, date, and note the time of transfer on the Chain of Custody form. If the transporter is not an employee of Golder Associates Inc., the laboratory sample custodian may identify the carrier and reference the bill of lading number in lieu of





the transporter's signature. The laboratory sample custodian shall retain the remaining copy of the Chain of Custody form and forward the original signed copy to the Geologist/Field Engineer. Appropriate laboratory custody procedures shall be initiated upon completion of transfer of custody in compliance with the laboratory's internal QA program requirements.

7.7. Document Tracking

The copy of the Chain of Custody form recording the initial transfer of samples shall be forwarded to the Geologist/Field Engineer, followed by the completed original. The Geologist/Field Engineer shall track the Chain of Custody form to ensure timely completion and receipt of the original, based on the laboratory acknowledgement due date indicated on the form and/or subcontractor agreement.

After receipt of the completed original, the Geologist/Field Engineer may discard the copy. The completed original Chain of Custody form shall be placed in the project files. Chain of Custody forms determined to be overdue or incorrectly completed shall be referred to the Project Manager for appropriate action.

7.8. Field Change Request

Variation from established guideline requirements may be necessary due to unique circumstances encountered on individual projects. All variations from established guidelines shall be documented on a Field Change Request form (Exhibit D) and reviewed by the Project Manager.

The Project Manager may authorize individual Geologist/Field Engineers to initiate necessary variations. If possible, the request for variation shall be reviewed by the Project Manager prior to implementation. If prior review is not possible, the variation may be implemented immediately at the direction of the Geologist/Field Engineer, provided that the Project Manager is notified of the variation within 24 hours of the implementation, and the Field Change Request is forwarded to the Project Manager within 2 working days of implementation. If the variation is unacceptable to either reviewer, the activity shall be redone or action shall be taken as indicated in the comments section of the reviewed Field Change Request. All completed Field Change Requests shall be maintained in project records.

8.0 REFERENCED GUIDELINES

Golder Associates Technical Guideline TG-1.2-2, "Geotechnical Rock Core Logging."

9.0 ADDITIONAL GUIDELINES AND PROCEDURES

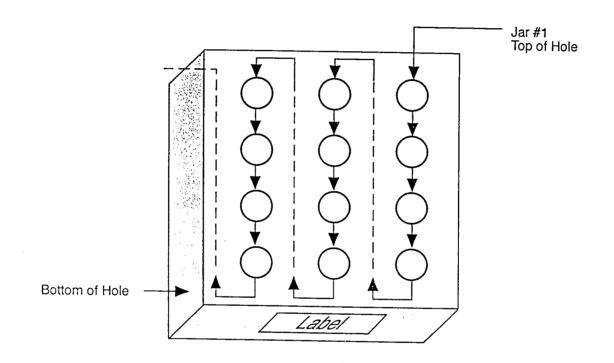
EPA, 2002, "Standard Operating Procedure for Chain of Custody of Samples," EPA Region 1 Office of Environmental Measurement and Evaluation, North Chelmsford, Massachusetts.

American Society for Testing and Materials, 2004. Standard Guide for Sampling Chain-of-Custody Procedures, ASTM D-4840-99(2004).





Figure 8-1



SAMPLE CONTAINER PACKING ARRANGEMENT TP-1.2-23



EXHIBIT A





Location Date Date Boring No Blows Description Date
DrillerEngr



Sample I.D. No.

Date Time
Station Depth
Media
Preservative
Sampled by

Golder Associates	Sent By:	
Seal Number	Date:	
2455 Golder Associates		

SEALS AND LABELS
TP-1.2-23



EXHIBIT B



SAMPLE INTEGRITY DATA SHEET

Plant/Site			
Site Location			
Sampling Location			
Technical Procedure Referer	nce(s)		
Type of Sampler			
Date	Time		
Media	Station		
Sample Type: grab	time composite	space composite	
Sample Acquisition Measureme	ents (depth, volume of static well	water and purged water, etc.)	
Sample Description —————			
Field Measurements on Sample	(pH, conductivity, etc.)		
Aliquot Amount	Container	Preservation/Amount	
Sampler (signature)	Date		
Superviser (signature) ——	Date		



Sample Integrity
Data Sheet
TP-1.2-23



EXHIBIT C



REMARKS (with initials) Received by: (Signature/Firm) Received by: (Signature/Firm) (M TO N C TOATM JA32 Remarks (attachments if necessary) Date/Time Date/Time ON THES Relinquished by: (Signature/Firm) Relinquished by: (Signature/Firm) CHAIN OF CUSTODY RECORD Date/Time PRESERVATIVE Received by: (Signature/Firm) Received by: (Signature/Firm) Received by: (Signature/Firm) SAMPLE IDENTIFICATION Date/Time Date/Time MEDIA SAMPLE TYPE SITE/LOCATION Relinquished by: (Signature/Firm) Relinquished by: (Signature/Firm) Relinquished by: (Signature/Firm) TIME SAMPLERS: (Signature) DATE PROJ. NO. STA. NO.

CHAIN OF CUSTODY FORM TP-1.2-23



TG-1.2-23 Chain of Custody

EXHIBIT D



FIELD CHANGE REQUEST	Golder
Job/Task Number:Other Affected Documents:Requested Change:	
Reason for Change:	
Change Requested by:	Date
Reviewed by:GAI Project Manager Comments:	Date
Raviowad by	
Reviewed by:GAI QA Manager Comments:	Date

Golder Associates Inc.

FIELD CHANGE REQUEST FORM
TP-1.2-23



TECHNICAL GUIDELINE FOR MANUAL GROUNDWATER LEVEL MEASUREMENT TG-1.4-6a

Rev. #5 8/21/2009





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Exhibit A Record of Water Level Readings



1.0 PURPOSE

This technical guideline is to be used to establish a uniform procedure for measuring groundwater levels in borings, drill holes, monitoring wells, and piezometers, by manual methods using an electric water-level sounder.

An alternate technical guideline (TG-1.4-6b, "Automated Groundwater Level Measurement") is to be used in conjunction with this guideline when making automatic water-level measurements using a pressure transducer and datalogger system.

2.0 APPLICABILITY

This technical guideline is applicable to all personnel measuring water levels in wells manually using a calibrated electric water-level sounder. It is not applicable to the measurement of water levels in flowing (Artesian) wells, unless sufficient additional casing is added to prevent the flowing conditions.

This guideline is not applicable for the measurement of water levels by other methods, such as wetted tape, air line, or pressure transducer.

3.0 DEFINITIONS

3.1. Electric Water Level Sounder

An instrument for manually measuring water levels in wells or boreholes. Electric water-level sounders are available in a variety of different types, but each works in essentially the same way, and consists of an open circuit involving a battery, ammeter, bulb, and/or audible beeper mounted within a reel of insulated two-wire electric cable. At the end of the two-wire cable is a weighted metal probe containing a partly-shielded electrode. The cable is graduated or marked to indicate the length of cable above the tip of the electrode in the probe. The circuit is closed when the exposed electrode in the probe is immersed in water. Current flow through the closed circuit is registered on the meter by illumination of the bulb and/or sounding of the beeper on the reel. This indicates that the probe has contacted water. Some sounders may have a sensitivity adjustment.

3.2. Well or Borehole

For the purpose of this guideline, any hole in the ground (cased or open) that may contain groundwater, e.g., a boring, borehole, drill hole, test pit, water well, monitoring well, observation well, pumping well, or standpipe piezometer.

3.3. Measuring Point (MP)

A reference or datum established to provide a consistent point from which the water level is measured, usually a mark on the casing at the top of a well or borehole. The elevation of the measuring point should be established by surveying (differential leveling) from a bench mark of known elevation above the local or national vertical datum. The elevation of the measuring point should be established to an accuracy of 0.01 ft or better. Use of the ground surface as a measuring point is acceptable for measuring water levels in wells and boreholes during drilling, and in other situations (e.g., test pits) where no other stable reference point is available. The measuring point should be clearly described in the field notes so that measurements to the same reference point can be reproduced, if necessary.





3.4. Diptube

A small-diameter (1- to 2-inch) tube (usually PVC) with slots over the lower 1 or 2 feet that is placed in a pumping well to provide a stilling effect that counteracts turbulence.

3.5. Pressure Transducer

A piece of electronic equipment used for measuring pressure (see TG-1.4-6b).

3.6. Datalogger

An electronic unit designed to collect and store data from a pressure transducer (see TG-1.4-6b).

3.7. Wetted Tape

Use of chalk on a measuring tape to sound the depth of water in a well. (This method is no longer in common use.)

4.0 DISCUSSION

4.1. Accuracy, Precision and Repeatability

The prime objectives in measuring a groundwater level are to obtain the depth to groundwater below a measuring point of known elevation, at a specific time, and in a manner that is both precise, accurate and repeatable (if the water level is static). Measurement precision of 0.01 ft is achievable with the fully graduated tapes available on modern electric water-level sounders. However, practical difficulties of calibrating long sounder tapes (e.g., >500 feet), and their sensitivity to stretching, reduce the accuracy of readings to, at best, 0.05 ft. This is usually adequate for most practical purposes. However, if a fixed measuring point is not available and the measurement is made in relation to the ground surface, this degree of accuracy and precision is not practical. Measurements made to ground surface should be recorded to the nearest 0.5 or 1.0 foot, and noted in the water-level record.

4.2. Measurements in Pumping Wells

Turbulence caused by pumping can make measurements of dynamic water levels difficult in wells that are being pumped. In this situation, a small-diameter diptube can be used to act as a stilling well. Measurements should be made inside the tube, provided it is long enough for the end of the tube to be submerged by at least 5 ft. If the top of the diptube is higher than the measuring point, this may be used as an alternate measuring point, but the difference must be recorded in the field notebook and on the Water Level Reading Forms (Exhibit A).

4.3. Potential Sources of Error

Be aware of the potential sources of error that can affect water-level measurements:

- Dirt, scum, oil, or floating product on the water surface can affect closure of the electric circuit in the water-level probe.
- The meter may not register if the electrical conductivity of the water is extremely low (e.g., deionized water).
- Cascading water, leaking casing, drilling mud, or excessive condensation in the wellbore can cause the water-level probe to signal contact with water before the probe encounters the static water level in the well. This effect may be overcome using the sensitivity adjustment (if





available).

- Changes in air pressure can cause small fluctuations in the water level.
- The water-level probe will not produce a signal if the battery is flat, if the switch on the reel is in the "Off" position, or if the sensitivity adjustment is set too low.
- In very deep wells (i.e., over 500 ft), the measurement of the water levels may be affected by non-verticality of the well, and by stretching of the electrical sounder tape.
- It is all too easy to misread the calibrated tape. Check each reading again immediately after noting it down.

4.4. Care of the Equipment

The electric water-level sounder is an expensive piece of equipment that should be treated with care:

- Avoid situations where the probe may become caught or stuck down-hole, for example, near casing centralizers or pump riser columns.
- Exercise control over the tape as it unwinds, especially into deep and/or uncased holes.
- Avoid abrasion of the electric tape against the lip of the casing: this causes excessive wear and eventual failure of the electric wires inside the tape.
- Rewind the tape evenly with markings visible, and avoid twisting or pulling on the tape.
- Clean and dry the tape and probe as they are removed from each well.
- Replace the probe in its protective sleeve (if available) after cleaning.
- Store the electric water-level sounder in a clean and dry, secure place.

5.0 RESPONSIBILITY

5.1. Field Engineer/Geologist/Hydrogeologist/Technician

Responsible for making and recording measurements in compliance with this technical guideline and taking reasonable care of the equipment while it is in their possession.

5.2. Task Leader

Responsible for:

- Direct supervision of personnel taking the measurements
- Designation of measuring points on wells or boreholes
- Determination of the maximum cable length required for the electric water-level sounder
- Guidance on the purpose, number, timing, and/or frequency of water-level measurements required
- Assurance that equipment and materials are available to complete the task





5.3. Equipment Manager (Where Applicable)

Responsible for:

- Maintenance of the electric water-level sounder in full working order
- Replacement or repair of damaged tape, probe, or other malfunctioning parts of the sounder
- Periodic calibration of the sounder tape to ensure markings are correct
- Procuring, checking, calibrating, and returning any water-level sounder obtained by rental.

6.0 EQUIPMENT AND MATERIAL

- Electric water-level sounder with integral cable of sufficient length for the well(s) being measured.
- Field notebook and/or appropriate Water Level Reading forms (Exhibit A).
- Data on well locations, identification number, depth, measuring point description and elevation above survey datum, and previous or most recent water-level measurements (if available).
- Decontamination solution, distilled/deionized rinse water, and a clean cloth or paper towels.
- Indelible ink pens.
- Spare battery for electric water-level sounder.

7.0 GUIDELINE

- Each water level probe or measuring tape used for recording water levels shall have the depth graduations calibrated by the Equipment Manager. Confirm that calibration is current by checking the "next due" date on the calibration sticker located on the equipment.
- Record project number, project name, location, and state.
- At each well, record the date, time, well identification number, measuring point description (e.g., top of PVC casing), measuring device type, manufacturer, and serial number and Golder equipment identification number (if applicable).
- Clean all downhole instruments and equipment before and after measurements and between wells with a non-phosphate detergent rinse followed by a rinse with approved tap water, then rinse with organic-free distilled/deionized water. The probe should be dried with a clean cloth or paper towel after cleaning.
- At least once at each well: measure and record the approximate distance from ground level to the measuring point. Measure the vertical distance from the top of casing, standpipe, monument, or other relevant points of reference to the measuring point, as appropriate.
- Turn on the electric water-level sounder, check the battery using the test switch or button, lower the probe into the well and stop at the depth where the bulb or audible beeper indicates a completed circuit. Raise and lower the water-level sounder a small distance to break and remake the circuit, confirming that the water level can be repeatedly identified, and carefully establish the point at which the sounder circuit just closes. Record the length of the tape





below the measuring point by reading the value indicated on the tape directly level with the measuring point, to the nearest 0.01 ft.

- Enter all water level measurements in a field notebook, or directly on a Water Level Readings Form (Exhibit A). The personnel making the measurement should initial or sign each measurement recorded, and make any additional comments pertinent to the data collected.
- If a field notebook is used, water-level measurements should be carefully transferred to a Water Level Readings Form (Exhibit A), if required, at the earliest convenient time. All water level measurement records shall be maintained in the project records files.
- Water-level measurements should be tabulated in a spreadsheet or entered into an electronic database file for project use. The spreadsheet or database should facilitate the calculation of water levels as elevations relative to the appropriate survey datum. New water levels should be reviewed for consistency with previous measurements from the same location (for example, by plotting a hydrograph). Significant deviations that lack a clear physical cause (e.g., seasonal recharge, influence of pumping, borehole construction changes, use of packers or slug tests, barometric influences, etc.) should be investigated. If necessary, spurious water-level measurements should be retaken and erroneous values annotated in the data record.

8.0 REFERENCED GUIDELINES

Golder Technical Guideline TG-1.4-6b, "Automated Groundwater Level Measurement".

9.0 ADDITIONAL GUIDELINES AND PROCEDURES

Driscoll, F.G., 1986. Groundwater and Wells. (2nd Edition) Johnson Filtration Systems Inc., St. Paul, Minnesota.

American Society for Testing and Materials, 2001. Standard Test Method for Determining Subsurface Liquid Levels in a Borehole or Monitoring Well (Observation Well), ASTM D-4750-87(2001).





EXHIBIT A



RECORD OF WATER LEVEL READINGS

Comments Location _ By Survey Mark Water Level Elevation Elevation Survey Mark Correction Measuring Device/Measurement Vater Level Serial No. Point (M.P.) below M.P. Project Name _ Tine Date Job. No. Bore-Hole No. At Golder Associates we strive to be the most respected global group of companies specializing in ground engineering and environmental services. Employee owned since our formation in 1960, we have created a unique culture with pride in ownership, resulting in long-term organizational stability. Golder professionals take the time to build an understanding of client needs and of the specific environments in which they operate. We continue to expand our technical capabilities and have experienced steady growth with employees now operating from offices located throughout Africa, Asia, Australasia, Europe, North America and South America.

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